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THE CONNECTICUT SEWERAGE COMMISSION ceased to exist on June 1, and a legislative bill to appoint a new commission has been killed in the house. A bill virtually continuing the old commission was amended in the senate so as to reduce the membership to three, who should be scientific men and receive $500 a year each, and be given $4,500 additional for expenses. The senate passed the amended bill, but in the house it was urged that the old commission had accomplished but little; that the bulk of its last report was written by men outside the state, and that advantage should be taken of the opportunity to get rid of a useless commission. Although several members endorsed the work of the old commission and supported the bill the latter was voted down, and later the senate concurred in the action.

THE ORGANIZATION OF THE U. S. BUREAU OF Public Health and the Marine Hospital Service was detailed at length in an address by Walter Wyman, M. D., Surgeon General of the Service, delivered on June 3 before the first annual conference of State and National Health Authorities, held under Congressional act of July 1, 1903. The new bureau, or old one reorganized and expanded, is in seven divisions, of which only two need be named here: (1) Sanitary Reports and Statistics; (2) Scientific Research. The first of these will publish weekly and monthly public health reports, including statistics of births, sickness, and deaths. To the Division of Scientific Research will be referred all matters relating to the Hygienic Laboratory. On the advisory board of the laboratory are, among others, Prof. Wm. T. Sedgwick, of the Massachusetts Institute of Technology, and Prof. Victor C. Vaughan, of the University of Michigan. To the Department of Bacteriology, carried on by the laboratory under the old regime, there will be added departments of zoölogy, chemistry, and pharmacology. The address was published in full in the "Medical Record" for June 13.

THE SEWAGE FARMS OF PARIS included a total of 10,823 acres at the close of 1901, according to the recently published report of Mr. M. G. Beshmann, Chief Engineer of the Water Supply and the Sanitation Departments of Paris. There are four different farms. More than half of the total area is owned by the municipality, but most of the farming work is done under contract. The farm at Gennevilliers, which is probably the best known of the four, outside of Paris, has an area of 2,224 acres, and yielded crops during the year valued at some $400,000. Part of the area, however, was used as a fruit and flower garden, largely for experimental purposes. The crops grown on the farm proper included onions, potatoes, asparagus and hay. On some of the other farms sugar beets, cereals, and still other crops were grown. The amount of sewage applied at the various farms ranged from 33,000 to 59,000 cu. m. per hectare per year, or from approximately 465,000 to 785,000 cu. ft. per acre per year. Expressed in U. S. gallons this would be about 3,485,000 to 5,880,000 per acre per year, or say 9,500 to 16,000 gallons per acre per day.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Pennsylvania R. R. near Osceola, Pa., on June 9. A freight train going up a mountain grade broke in two, and the rear section running back struck another freight. Three men, belonging to the crew of the second train, were killed.—On June 9 a northbound through passenger train on the Louisville & Nashville R. R. left the track when on a curve on a high embankment near Louisville, Ky. Many persons were injured in the wreck, but only one was killed.

THE SLOW SAND FILTRATION PLANT for a portion of the water supply of New Haven, Conn., is to be built, or completed, by Eglee & Bunting, of Boston. Preliminary work was begun some time ago by the New Haven Water Co.

A SUDDEN FLOOD, resulting from an extraordinary rainfall, destroyed the town of Heppner, in northern Oregon, on Sunday, June 14. Some fifteen or twenty miles below Heppner the smaller town of Lexington was also overwhelmed. It is reported that several hundred people were killed in the two towns. Heppner is about forty miles south of the Columbia River, and the foothills of the Blue Mountains are from five to thirty miles back of the town. Willow Creek with several tributaries drains this region, discharging into the Columbia River. According to present reports a heavy rain fell during June 14; toward evening a sudden flood wave came down Willow Creek and swept away the larger part of the town, which had no warning of the coming flood.

THE LORAIN SURFACE CONTACT TRAMWAY at Wolverhampton, England, has been ordered removed, on vote of the town authorities, because of its greater operating cost over the overhead trolley system. In our issue of May 7, 1903, we made note of a report by the electrical engineer of the borough regarding the working of the system during the past year. The equipment of the 11 miles of line with the Lorain system, completed over a year ago, was made under the contract condition that if after one year's operation the system should not prove a "commercial success" as compared with the overhead trolley the borough need not accept it. The engineer's report showed that while the system was sufficiently safe and reliable, the cost of maintenance and inspection was higher, and more current was required per car-mile. On this showing the town authorities, after some debate, decided by a vote of 28 to 17 not to accept the line.

THE FATE OF THE PANAMA CANAL TREATY appears to rest with the Colombian Congress which assembles on June 20, and reports represent the parties in favor of the treaty and opposed to it as about equally divided. What course the United States will take in case the treaty is rejected remains to be seen; but a new treaty with Nicaragua and Costa Rica for the use of the Nicaragua route is said to be under consideration and it is also claimed that a disruption of Colombia may result after which the United States could close a treaty with the section of the country favoring the canal.

AN INTERNATIONAL CONGRESS ON ELECTRICITY will be held in conjunction with the Louisiana Purchase Exposition, during the week beginning Sept. 12, 1904, at St. Louis, Mo. A committee on organization has been appointed to promote the congress, issue the invitations and prepare the official program, whose officers are: President, Prof. Elihu Thompson, of Swampscott, Mass.; Vice-Presidents, Prof. H. C. Carhart, University of Michigan; Mr. C. F. Scott, Pittsburg, Pa.; Prof. W. E. Goldsborough, Purdue University; Mr. W. S. Stratton, Washington, D. C.; Secretary, Prof. A. E. Kennelly, Harvard University; Treasurer, Mr. W. D. Weaver, New York city. A number of electrical organizations, such as the American Institute of Electrical Engineers, the American Electrochemical Society, and the National Electric Light Association have already planned to hold meetings in St. Louis in conjunction with this congress. A congress on Arts and Sciences will be held during the following week, and many of the scientists attending either congress will probably also join in the other.

THE THREE 16,000-TON BATTLESHIPS, recently authorized by Congress, bids on which were reported in our issue of June 11, are to have the following dimensions and equipment: Length between perpendiculars, 450 ft.; length over all, 456 ft. 4 ins.; extreme breadth, 76 ft. 8 ins.; depth, 46 ft.; draft, 24 ft. 6 ins.; displacement, 16,000 tons. The hull will be plated with ½-in. steel, with a double bottom. A cofferdam 7 ft. high and 30 ins. wide, filled with corn-pith cellulose, protects the waterline. The power equipment includes 12 water-tube boilers having a heating surface of 46,750 sq. ft. and a grate surface of 1,100 sq. ft.; they will carry a pressure of 265 lbs. Two triple-expansion engines with four cylinders each will drive the vessel; the cylinders will be 32½, 53, 61 and 61 ins. by 48 ins., and the total power of both engines is 16,500 HP., at 120 r. p. m. Two main condensers of 10,375 sq. ft. of condensing surface are provided. The contract speed of the vessels is 18 knots. The defensive armor comprises a protective deck of 1½-in. nickel steel on the flat and 3-in. on the slopes; a main armor belt 284 ft. long by 9 ft. 3 ins. wide amidships and 8 ft. wide at the ends, of thickness varying from 9 ins. amidships to 4 ins. at the ends; a casemate of 7-in. armor for the broadsides; barbettes of 10-in. to 6-in. plates for the four large guns and 6-in. to 4-in. plates for the eight 8-in. guns, the turrets for these guns being of 12-in. to 8-in. plates and 6½-in. to 6-in. plates respectively. The 3-in. guns of the secondary battery are protected by 2-in. nickel-steel plates. The armament comprises four 12-in. guns, eight 8-in. guns (these twelve in six turrets) and twelve 7-in. guns, and a secondary battery of twenty 3-in. 14-pounder rapid-fire guns and 28 other pieces. Two military masts 75 ft. high are provided, one at each end of the superstructure. The lighting of the vessel and the operating of cranes, pumps, ammunition hoists, deck winches and machinery for maneuvering guns and turrets, will be electric, the current being supplied by eight 100-KW. generators for 125 volts (the new Navy standard pressure). Each vessel carries a wireless telegraph outfit. We are informed that the "Vermont," one of the three new vessels, will be built by the Fore River Ship & Engine Co., of Quincy, Mass., who have already begun the preliminary work.

A SYSTEM OF PROTECTING EARTH SLOPES from erosion has been recently patented by E. Moody Boynton, of West Newbury, Mass., who will be remembered by many engineers as the inventor of the Boynton Bicycle Railway, exploited to some extent a dozen years ago. The system consists of embedding willow sprouts in the face of the bank and holding them in place by a wire network while they are becoming rooted and firmly fixed in place. A clay slope at Pipestave Hill in the town of West Newbury, nearly a mile in length and 30 ft. in height, is reported to be undergoing treatment by this system.

THE PRODUCTION OF ALUMINUM is given in a report on aluminum and bauxite for 1902, by Dr. Joseph Struthers, just issued by the United States Geological Survey. The production of aluminum in the United States during 1902 was approximately 7,300,000 lbs., as compared with 7,150,000 lbs. in 1901, the sole producer being the Pittsburg Reduction Company, which has large plants in operation at Niagara Falls and at Shawinigan Falls, Quebec, Canada, and is installing a large plant on the St. Lawrence River near Massena, N. Y.

PAYING EMPLOYEES BY CHECK instead of in currency is to be inaugurated on the Pacific system of the Southern Pacific Co. after July 1. The checks will be drawn to the order of the employees and may be cashed by station agents as well as through ordinary banking channels.

THE U. S. GEOLOGICAL SURVEY has now ready for distribution the following atlas sheets: Bonner Quadrangle, Montana; Aladdin Quadrangle, Wyoming; Camden Quadrangle, Arkansas; Rock Creek Quadrangle, California; Park City (Utah) Special Map; and Encampment (Wyoming) Special Map. The contour intervals are 50 and 100 ft.

THE RARITAN RIVER STONE ARCH BRIDGE OF THE PENNSYLVANIA R. R., AT NEW BRUNSWICK, N. J.

In our issue of Jan. 30, 1902, we illustrated and described the plans for the four-track stone arch bridge over the Raritan River at New Brunswick, N. J., on the New York Division of the Pennsylvania R. R. This bridge was planned to replace an iron bridge carrying two tracks and the arrangement was to build one-half the width of the

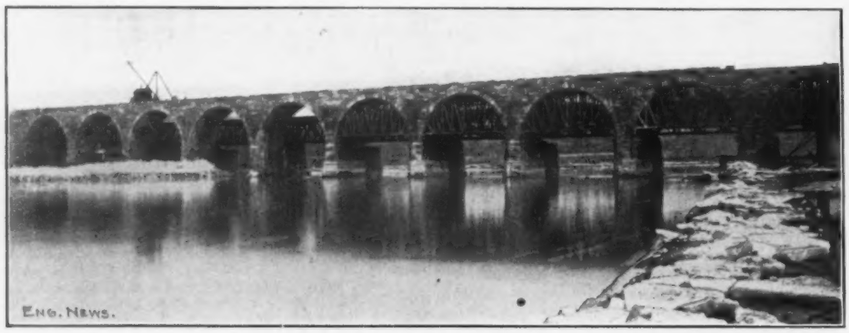


FIG. 2. VIEW OF COMPLETED PORTION OF PENNSYLVANIA R. R. BRIDGE OVER THE RARITAN RIVER AT NEW BRUNSWICK, N. J.

Wm. H. Brown, Chief Engineer, Pennsylvania R. R.; H. S. Kerbaugh, Inc., Philadelphia, Pa., Contractor.

structure alongside the iron bridge, then, after transferring the tracks, to remove the latter and complete the second half. The first half of the work as planned has now been completed, and as soon as the embankment approaches are constructed tracks 3 and 4 will be transferred to it. The accompanying illustrations show the completed portion of the new bridge and the general methods adopted in its construction.

Briefly described, the new bridge is 1,500 ft. long, 57 ft. wide from out to out of coping, and approximately 65 ft. high. It consists of 21 spans of varied sizes; ten river spans of 66 ft., two canal spans, 56 ft.; eight land spans, 51 ft.; and one land span at the extreme west end over Neilson St. of 72 ft. The arch rings, sheeting, spandrel walls, pier facings and coping, are of the finest Pennsylvania mountain sandstone, obtained from the Conemaugh Stone Co.'s quarries in Cambria and Clearfield counties, Pa. This sandstone has been found by the Pennsylvania R. R. Co. to resist the action of fire, frost, and erosion by the weather better than any other material. The backing in the piers and the haunching over the arches are composed of ordinary heavy rubble masonry laid in Portland cement, with as much care as the face stone. All cement mortar and grout were made of Portland cement and sand, the composition being two parts sand to one part of cement. Work was commenced on the bridge proper in March, 1902, and all arches were completed in December, excepting the two canal arches, which were finished after navigation in the canal closed.

The new bridge is mainly of interest because of its magnitude and the method of construction followed. Next to the Rockville Arch Bridge on the Middle Division of the Pennsylvania R. R. (Eng. News, May 10, 1900, and Dec. 12, 1901), which is 3,820 ft. long, the New Brunswick Bridge is the longest stone arch bridge in the world. The method of construction was as follows:

The first construction work was the placing of the pier footings. This was done by means of cofferdams, framed in place, and puddled with clay. The river bed was of loose rock, and had to be excavated from 6 ft. to 8 ft. to remove the unsound surface rock. The tide has a rise and fall of approximately 5 ft. The necessary pumps and derricks were installed on flatboats, and the construction material was delivered along the work, by means of a temporary pile trestle track, running parallel to and close along the bridge site. The beginning of this trestle track is shown by Fig. 4.

The arches were built on truss centers of yellow pine. Each center consisted of eight parallel trusses made up of sawed timber, as shown by Fig. 1, which gives the details of one of the trusses for a center of 56-ft. span. The drawing gives all the details and dimensions. The strap and gusset plate connections will be noted. The center ribs are carried at the ends on framed bents which have their bottom sills resting on the set-off of the pier footings. The ribs are wedged up on the bents, and as will be noted from the drawings rollers are inserted, by means of which the centers for the first half span can be moved out and into position for the second half span. The view, Fig. 2, shows the centers in position for a number of the spans. Fig. 3 is a view of the inner side of the first half and shows the character of the masonry.

The height of the bridge, 65 ft., made it difficult to turn the arches by regular method of derrick construction. To handle the material for the arches of the bridge boom-swinging derrick travelers were employed, running on a trestle work carried by the centers or by the completed arches. Altogether, three travelers were used, which set all the sheeting, and placed the centers. The view, Fig. 4, shows the derrick at work erecting the center for one of the end arches.

The site of the new bridge was directly on that covered by the steel bridge. Though the plan called for the construction of the stone arch bridge in two sections, each section, half the width of the completed bridge, there was still no room for the half bridge alongside the old one, so the steel

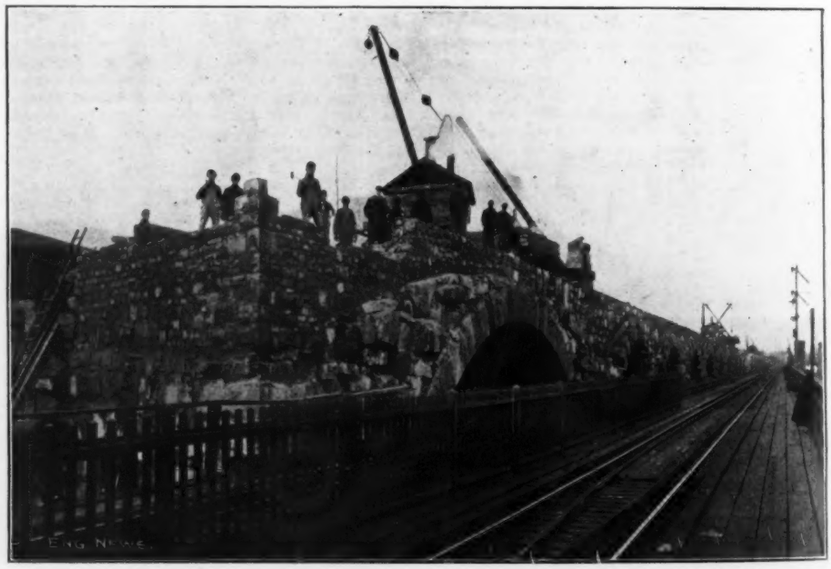


FIG. 3. VIEW OF RARITAN RIVER BRIDGE, SHOWING MASONRY TO WHICH SECOND HALF WILL BE JOINED.

bridge was moved down stream 15 ft. This feat was performed on May 26, 1902, in one minute and forty-five seconds. The weight of the bridge moved, including the draw span, was approximately 2,000 tons.

The new stone bridge was practically started in May, and the north section completed in seven months, there being no accident or delays to the enormous traffic which passed over the adjoining tracks. The plans and specifications were designed in the Pennsylvania R. R. offices, by Mr. Wm. H. Brown, Chief Engineer, and Mr. Wm. C. Bowles was Assistant Engineer in charge of construction. The work was done by H. S. Kerbaugh (Incorporated), Contractor, Philadelphia, under the direction of Mr. Frank Brown.

A MEDICAL AND SURGICAL OUTFIT FOR CAMP USE.

In our issue of May 7 we published a number of descriptions of medical and surgical kits for engineering parties. In "Forestry and Irrigation" for May, we find the same subject discussed in a paper by Dr. John Gifford, of the New York State College of Forestry. We reprint Dr. Gifford's paper as follows:

The ordinary medical and surgical emergency outfits, as prepared by drug houses for parties living in regions far away from physicians and drug stores, are for several reasons unsatisfactory for the forester. Many of these outfits contain drugs of doubtful medicinal value. Some contain drugs which should never be placed in the hands of others than regular physicians. Others lack the common but efficient household remedies with which men of ordinary intelligence and experience are familiar. Many contain drugs which are never used, and none familiar to the writer seem especially fitted to the needs of men living for several weeks in remote districts.

In cases of illness it is, of course, always proper to call in a physician; but the backwoods doctor is often so far behind the times that one is safer without his services. In cases of light illness a doctor is very often an unnecessary expense.

Whether doctors are available or not, it is nothing short of criminal negligence to send a party into the woods for a considerable stay without an emergency outfit.

A careful, intelligent member of the party should be given sole charge of the emergency kit. He should administer medicines and order more when one or more articles are exhausted. This should be done at once, because the most useful articles are the ones first exhausted. Many expeditions have with good intentions started out wth complete emergency outfits, but which, owing to lack of replenishment and care, soon became useless impediments.

It should always be borne in mind that to the sick and wounded first aid is the important aid. Serious illness and even death may be averted by doing the proper thing at the proper time. This aid is often slight and of such a nature that a thoughtful, intelligent person can give it as well as an experienced physician.

I have had charge of an emergency outfit for several years. This has undergone and is still undergoing change. A lot of medicines recommended by doctors whom I have consulted have been discarded and only those are carried which I have found most useful. Other persons might prefer other kinds, for in matters of this nature there is ample room for diversity of opinion. I have been frequently asked for a list of the materials in my chest. I give it below for the benefit of those in need of such an outfit:

FIG. 3. GAP IN MAIN COFFERDAM.

FIG. 4. VIEW OF DAM UNDER CONS

FIG. 6. CLOSING GAP IN MAIN COFFERDAM.

FIG. 10. MASONRY OF RIVER

THE SPIER FALLS DAM OF THE HUDSON

Charles F. Parsons, Chief Engineer; Wm. Barclay Parsons, M. Am. Soc. C. E.

OF DAM UNDER CONSTRUCTION.

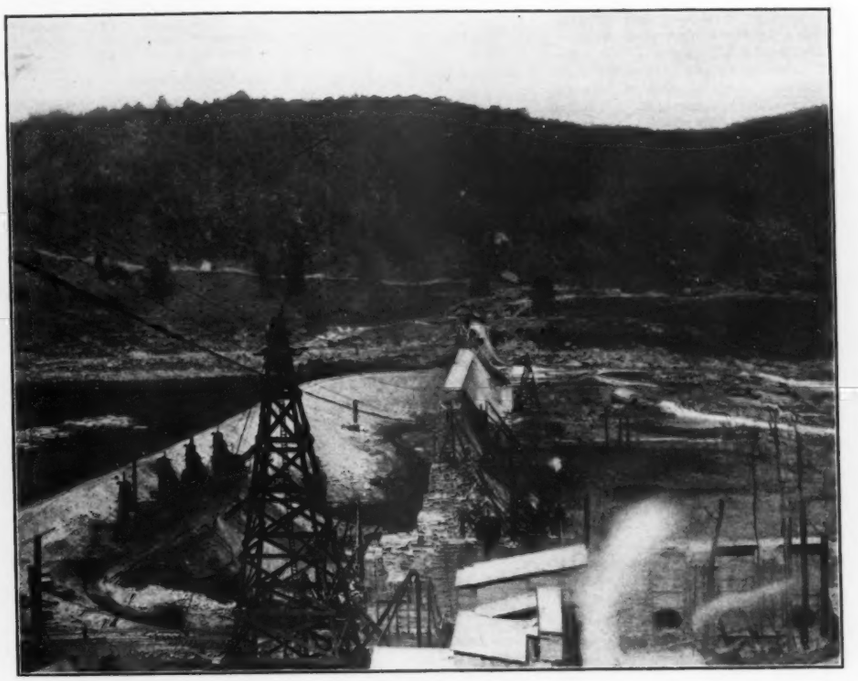


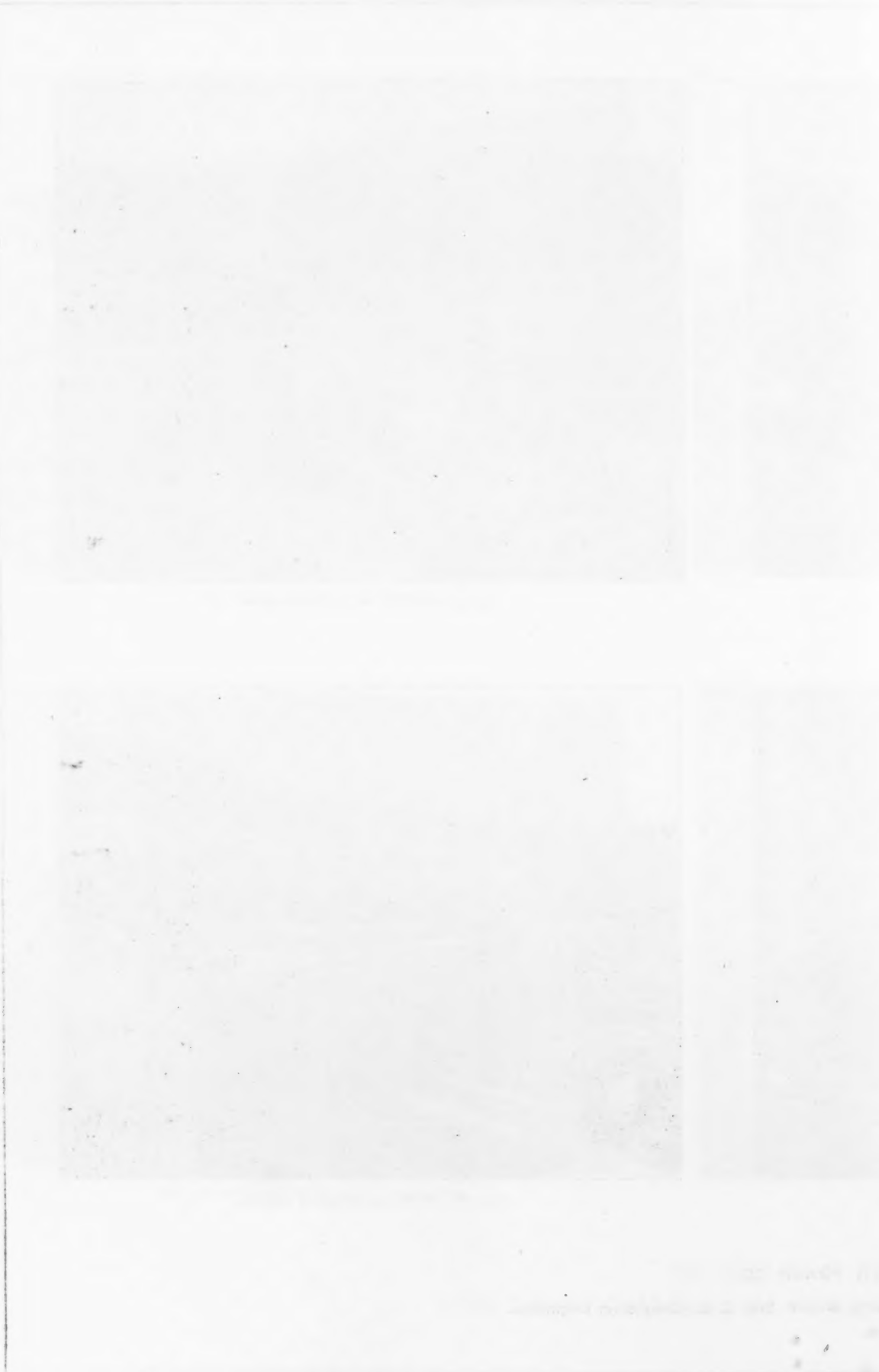
FIG. 5. VIEW OF MAIN COFFERDAM.

MASONRY OF RIVER SECTION.

FIG. 11. STIFF LEG DERRICK PLANT.

THE HUDSON RIVER WATER POWER CO.

. Am. Soc. C. E., and G. E. Evans, M. Am. Soc. C. E., Consulting Engineers.



1. A pocket Cyclopedia of Medicine and Surgery, by Gould and Pyle.
2.* Quinine, 2 gr. pills. For malaria, fever, cold, and general tonic. As a general tonic and preventive against malaria, one after each meal.
3. Anti-malaria. Quin. sulph., 1½ gr.; acid arsen, 1-32 gr.; powd. capsicum, ½ gr. Two every three hours for chronic and acute malaria.
4. Oil of citronella. Since malarial fevers are transmitted by mosquitoes the damage of infection is much reduced and comfort secured by the free use of this oil on face and hands. The genuine should be used, and not cheap, ineffective substitutes.

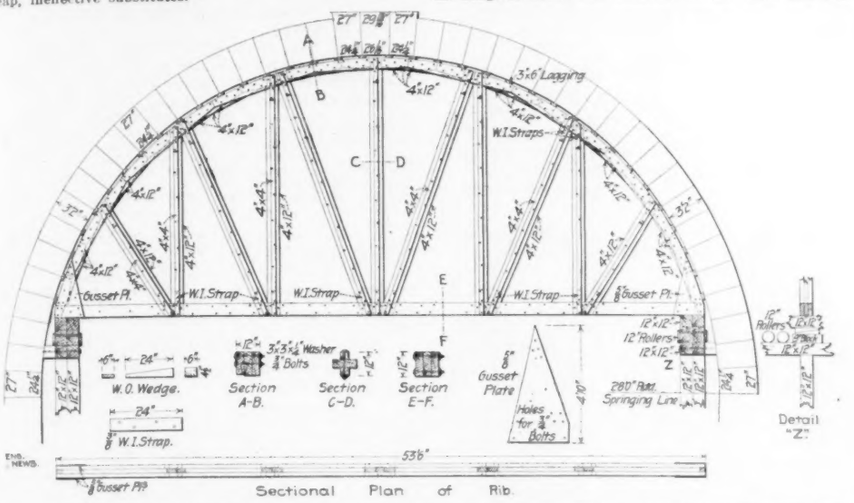


FIG. 1. DETAILS OF TRUSSED RIB FOR CENTER FOR 56-FT. ARCH SPAN, RARITAN RIVER BRIDGE.

5. A. S. and B. pills for chronic constipation. Aloin, 1-5 gr.; strych. sulph., 1-60 gr.; ext. belladonna, ⅛ gr. Two tablets at night for torpid liver and as a laxative in chronic constipation.
6. Excellent laxative. Ext. cascara sag., 1 gr.; ext. nux vom., ⅛ gr.; ext. belladonna, ⅛ gr.; ipecac powd., ⅛ gr.; podophyilin, ⅛ gr. One to three at night.
7. Calomel, ¼ grain. One every two hours until cathartic action is produced, followed by seidlitz powder or epsom salts, for biliousness and torpid liver.
8. Seidlitz powder.
9. Epsom salts.
10. Sun cholera mixture. Tr. opium, 3 min.; tr. rhubarb, 5 min.; tr. capsicum, 5 min.; spt. peppermint, 5 min.; spt. camphor, 5 min. Indicated in diarrhœa attended with profuse watery discharges and prostration. One to two every three or four hours or as needed.
11. Calomel and capsicum comp. for diarrhœa with cramps. Calomel, ⅛ gr.; morph. sulph., 1-16 gr.; powd. capsicum, 1-16 gr.; powd. ipecac, 1-32 gr.; camphor, 1-16 gr. One every hour or two as necessary.
12. Lime-water tablets. For acidity and nausea. In the mixture known as carron oil (a lotion of linseed oil and lime water), excellent for burns and scalds.
13. Phenacetine, 1 gr., five at a dose, repeated as necessary, for neuralgia, rheumatism, and headache. Excellent in headache and neuralgia in combination with caffeine.
14. Cold in the head. Camphor, ¼ gr.; quin. sulph., ¼ gr.; morphine sulph., 1-64 gr.; atropine sulph., 1-2,000 gr.; ext. glycyrrhiz, ½ gr. One to two every half hour or so.
15. Liniment tablets. Camphor, capsicum, ext. belladonna aa, 6½ grs. Dissolve one tablet in one oz. alcohol.
16. Brown mixture comp. for coughs and colds. Ext. licorice, 1-20 gr.; camphor, 1-50 gr.; acid benzoic, 1-50 gr.; oil anise, 1-50 min.; opium powd., 1-50 gr.; tartar emetic, 1-120 gr. Dissolve one in the mouth every half hour, stopping as the symptoms lessen and the cough becomes free.
17. Olive oil.
18. Camphor.
19. Leadwater and laudanum tablets. One tablet to 1 oz. of water. For sprains, bruises, and poisons due to sumac.
20. Carbolized vaseline. For all kinds of skin abrasions and wounds.
21. Sulphur and ichthyol ointment for skin diseases and all parasitic skin affections.
22. Blue ointment (poison). For chronic ulceration and animal parasitic affections of the skin. Excellent for the prevention of rust on fire-arms.
23. Zinc ointment. For skin diseases and chronic sores.
24. Potass. permanganate, 2 grs. Antidote to morphia. Useful when locally applied in bites of poisonous snakes and insects.
25. Corrosive sublimate. One tablet to one pint of water makes a solution of 1:1,000. Valuable germicide. Tablets should be colored green and stamped with the word "poison."
26. Formalin. A 40% aqueous solution of the gas formaldehyde. A powerful disinfectant and deodorant. Weak solution (0.5%) may be used as gargles and mouth washes and stronger ones (2½%) as lotions for skin diseases. Formaldehyde is manufactured from wood alcohol.
27. Aristol, a valuable antiseptic powder, combination of iodine and the oil of thyme; free from disagreeable odor; excellent dusting powder for ulcers, wounds, and skin diseases; with vaseline as a base, excellent for the poison due to sumac.
28. Iodoform, an antiseptic powder commonly used on wounds, ulcers, and skin diseases; possesses a disagreeable odor.
29. Iodine, used locally in the form of tincture for sprains, bruises, chronic rheumatism, etc.; used only locally in the form of tincture or ointment; applied as a paint with a camel-hair brush.
30. Anæsthetic. Camphor, ¼ gr.; morphine mur., 1-24 gr.; oil cajeput, 1-24 min. One every hour for relief of pain and diarrhœa. The oil of cajeput is distilled from the leaves of the fever tree of the East Indies. The scientific names of this tree is Malaleuca leucandendron.
31. Trional, 5 grs. to produce sleep.
32. Brandy, difficult to keep in stock.
33. Alcohol.
34. Ammonia.
35. Turpentine.
36. Glycerine.
37. Linseed oil.
38. Ground mustard for plasters.
39. Ground flaxseed for poultices.
40. Castor oil.
41. Surgical outfit and sundries: Cheese cloth and red flannel for bandages; absorbent cotton; 2 certified fever thermometers; surgeons' soap; scalpels and tweezers; needles and ligatures; metric glass graduates; ⅛ doz. pipettes; ½ doz. assorted camel-hair pencils; adhesive plaster; mustard leaves; bandage scissors; small glass syringes; one hot-water bag; one fountain syringe for enemas; one rubber bandage; one pair thin leather anklets.

Instructions in reference to the use of these medicines may be found in Gould's Pocket Medical and Surgical Dictionary.

The cost of the outfit depends, of course, upon the amount needed, which depends in turn upon the size of the party. Of some of the drugs only small quantities are needed. Phenacetine aristol, and trional are expensive. The other drugs recommended are comparatively cheap. As near as can be easily estimated, $20 will purchase an outfit sufficient for a party of considerable size for one season.

*These doses are for adults only.

COMPRESSED-AIR MOTORS FOR GATHERING CARS IN COAL MINES.*

By Beverley S. Randolph,† M. Am. Inst. M. E.

While the coal-mining practice, in regard to hauling on main roads, has advanced very rapidly in recent years by means of compressed air, electricity and ropes, that of gathering from rooms or working places has remained almost stationary. Few large mines are without some method of mechanical haulage on main roads, but the gathering from working places is still done almost entirely by means of animals or men.

An effort to improve this has been made recently by the Consolidated Coal Co., under the direction of the writer, at its mines in the Georges Creek region. The seam worked is the Pittsburg Bed, known locally as the "Big Vein." It is from 8 to 12 ft. thick. Immediately overlying the coal there is from 5 to 6 ft. of "rashings," consisting of thin alternating beds of shale and coal, which disintegrate rapidly on exposure to the air, and makes a very treacherous roof.

Rooms are driven 12 to 15 ft. wide, with a single track close to one side. A line of posts is placed just far enough from this side to leave a clear space for the mine car with a driver at the brake. This brings the post not far from the middle of the cross bar, and provides more effectual support than if placed at the end. The tracks in these rooms are usually of 4 × 4-in. oak scantling, though of late years, owing to the advance in the price of lumber and the reduction in steel rails, more of the latter are being used. This track is laid by the miner. His pay for the work is included in the price per ton for mining. It is therefore, as a rule, unskillfully and often carelessly laid, and cannot be relied upon to carry safely any weight materially greater than the loaded mine car.

Compressed air was already in use on the main roads, driving motors weighing 30,000 lbs. each, which are used to haul the mine cars that have been assembled from the rooms, bringing them to the foot of a slope, from where they are hauled to daylight by means of a rope.

*A paper read at the Albany meeting of the American Institute of Mining Engineers.

†Mine Supt., Cons. Coal Co., Frostburg, Md.

At the suggestion of the writer, the Baldwin Locomotive Works designed a motor, having the dimensions and general character shown in the accompanying cut, and guaranteed not to weigh more than 8,000 lbs. when charged. Loaded mine cars frequently weigh 7,000 lbs. gross, and their outside dimensions are then practically the same as the motor just mentioned.

Five of these machines were placed in the company's Ocean No. 3 mine (Hoffman), displacing a number of mules, but leaving 19 still working. This opportunity was embraced to make a close comparison between the two methods of gathering.

COST OF MULE HAULAGE.

The mules working in the north heading and the south heading deliver their cars directly to the rope on the slope. The other mule routes deliver to the heavy motors mentioned above, as do all the motor routes. The mules used weigh from 1,200 to 1,400 lbs., and are the best obtainable. Mine cars weigh 1,000 lbs., and carry an average of 2.4 long tons.

The following table shows the work performed by the mules during a period of 18¾ working days in the month of December, 1902:

Route	Cars moved.	Average haul, ft.	Constant. 2-4	Tons moved 1,000 ft.
South heading	1,119	2,900	1000	7,788.24
North heading....	268	1,300	"	836.16
First cross	1,629	2,100	"	8,210.16
Second "	3,042	1,110	"	8,030.88
Third "	747	400	"	717.12
Total				25,582.56

This represents a total of 339 days' work for one mule.

The company's accounts show a cost of $1.15 per day for each day worked by a mule, including expense of replacing worn-out animals. Drivers are paid $1.98, and there is one with each mule. This makes a cost of $3.13 per day for each day worked by a mule. The cost per ton hauled 1,000 ft. would therefore be

$$\frac{339 \times \$3.13}{25{,}582.46} = 4.15 \text{ cts.}$$

COST OF MOTOR HAULAGE.—For the work of the motors during the same time we have:

Route	Cars moved.	Average haul, ft.	Constant. 2-4	Tons moved 1,000 ft.
Tippens	1,122	2,300	1000	6,193.44
Scobies	1,073	2,050	"	5,279.16
First Klondyke ...	1,147	1,835	"	5,046.80
Second " ...	1,032	1,800	"	4,458.24
Third " ...	1,147	1,865	"	5,138.56
Fourth " ...	114	1,992	"	544.92
Total				26,661.12

This work was done by the five small motors operated by compressed air, working a total of 94 days.

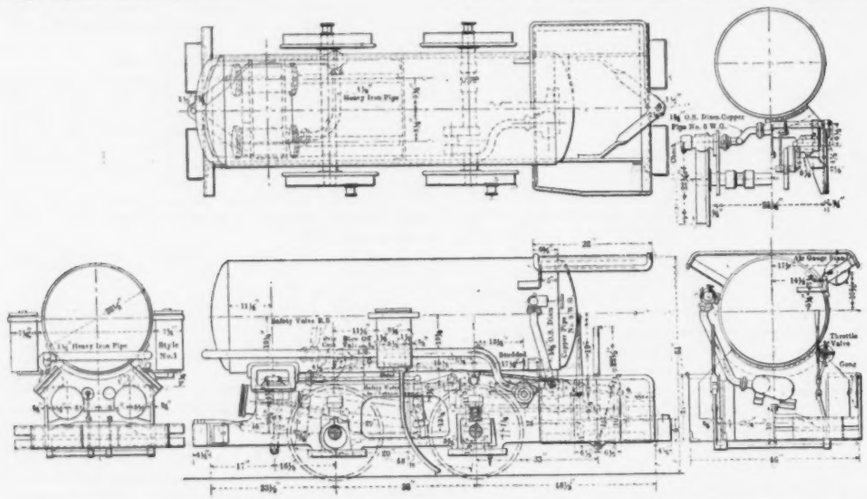
Fig. 4. View Showing Traveling Derrick Erecting Center for Raritan River Bridge.

This plant is supplied with steam by a battery of boilers, which also supplies steam to the large pumps. The plant consists of the following items, with their approximate first cost:

One straight line Norwalk air compressor, 18 and 28 compound steam, 18½, 13½ and 6½ three-stage air, 30-in. stroke..	$5,300
5,600 ft. 5-in. pipe	5,600
3,100 " 2½-in. pipe	1,700
1,000 " 1½-in. pipe	300
2 motors, 30,000 lbs. each	6,000
5 motors, 8,000 lbs. each	10,000
Estimated proportion of boilers	1,000
Installation	4,000
Total	$33,900

Allowing $3,000 per year for interest and depreciation, to be earned in 300 working days, would justify a charge of $10 per day from this source against the entire plant.

This same compressor also drives the large motors mentioned above, which weigh 30,000 lbs. each (60,000 lbs. for the two); the five small machines weigh 8,000 lbs. each (40,000 lbs. for the five). Dividing the general expenses according to the weight would result in four-tenths being charged against the small motors.



COMPRESSED AIR LOCOMOTIVE USED BY CONSOLIDATION COAL CO., FROSTBURG, MD.

These general expenses may be summed up as follows per day:

Coal, 4 tons at $1	$4.00
Firemen	2.00
Mechanic in charge of compressor	2.50
Interest and depreciation	10.00
Total	$18.50

The daily cost of operation of the five small motors would then be

5 motormen at $2.67	$13.35
5 brakemen at $2.03	10.15
General expenses, $18.50 × 0.4	7.40
Repairs and oil	3.00
Total	$33.78

Dividing this among the five machines would give $6.78 per day for each machine, and the cost per ton moved 1,000 ft. would be

$$\frac{6.78 \times 94}{26{,}661.12} = 2.44 \text{ cts.}$$

In the matter of continuity of service, the motors show to great advantage. A broken-down motor can usually be repaired over night, while an injured mule can only be replaced by a new one that must usually be broken and inured to the work before he is thoroughly efficient, entailing loss of time and output in each case.

In the actual placing of cars in the workings, the motor has little or no advantage over the mule. After the train is made up, its higher speed and larger load place the mule at a great disadvantage. The showing of the motors may, therefore, be expected to be better with long hauls than with short.

Owing to the fact that it is the practice in this mine to send the same motor or mule on different routes, depending on where miners may be loading coal, it is impracticable to present any discussion of this feature from the data at hand.

ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The 35th Annual Convention of this Society was held last week at Asheville, N. C., at the Battery Park Hotel. Members from New York and points further east traveled thither on a special Pullman train leaving New York on Monday at 11 a. m., and arriving in Asheville at 9 a. m. on the following day. The total number of members and guests registered in attendance was nearly 250, a very large number for a convention held at a point so far distant from the "center of gravity" of the membership.

The first session on Tuesday afternoon opened with a formal welcome to the members by Mr. J. L. Ludlow, of Winston-Salem, N. C., chairman of the local committee, and a brief address eulogistic of the engineering profession by Gen. Theo. F. Davidson, of Asheville. President Alfred Noble made suitable acknowledgment on behalf of the Society, and then took the chair for the business meeting. The first matter taken up was the time and place of the next annual convention. Secretary Hunt stated that as St. Louis had long been tacitly understood to be the place for the convention of 1904, the usual informal letter ballot of the membership upon the subject had not been taken. Letters extending an invitation to the Society to meet in St. Louis next year were read from D. R. Francis, President of the Louisiana Purchase Exposition; Hon. Rolla Wells, Mayor of St. Louis; the St. Louis Business Men's League; and from J. A. Ockerson, M. Am. Soc. C. E., on behalf of the members resident in St. Louis and vicinity, and the Engineers' Club of St. Louis. The whole matter was referred to the Board of Direction without discussion.

A proposed amendment to the Constitution was then taken up changing in several particulars the manner of admissions to the Society. The main features of the amendment are that all applications hereafter will be for admission to the Society, and the Board of Direction will decide whether the applicant shall be graded as a Junior, Associate or full member. At present 7 blackballs exclude an applicant, and there is a chance for a reconsideration for which the vote is taken on a "pink ballot," and 2% of the votes cast are necessary to exclude. Under the new system the reconsideration is done away with and 20 negative votes are necessary to exclude a candidate. The Board of Direction elects Juniors and Honorary Members without submitting them to a vote of the Society at large, and can transfer from a lower to a higher grade of membership. Such transfers of Juniors, however, must be voted on by the Society.

A few amendments were adopted by the convention. One of these raises the limit of age of Juniors to 32 years, at which time, if they have not been transferred to a higher grade of membership, their connection with the Society ceases. Another provides that a rejected candidate may renew his application if he so desires after the expiration of one year. As amended the proposed changes will be submitted to a general letter ballot of the Society.

THE PROPOSED CO-OPERATION WITH OTHER ENGINEERING SOCIETIES IN THE ACCEPTANCE OF MR. CARNEGIE'S OFFER FOR A UNION ENGINEERING SOCIETY HOUSE.

Next on the program came the matter of most general interest in connection with the entire convention. The Secretary read first a brief statement of the inception of the project and of Mr. Carnegie's offer, and of the organization of a committee made up of three from each of the several societies concerned to prepare a plan for the acceptance and utilization of the offer. The resolutions proposed by this joint committee for submission to the several societies were printed in Engineering News of May 21, p. 455.

On June 2, the Board of Direction of the American Society of Civil Engineers held a meeting at which the following resolutions were adopted:

Whereas: The resolutions submitted by the Joint Conference Committee in the matter of the proposed Union Engineering Building are not in suitable form, in the opinion of the Board of Direction of the American Society of Civil Engineers, to be submitted to the Society;

Resolved, That it is the sense of this Board that the proposition when submitted to the Society should make definite provision for the accommodations necessary for the present and future needs of the several organizations, and that the proportion of the total expense to be borne by each of the organizations should be definitely stated; and be it further

Resolved, That the Board of Direction recommends to the Business meeting to be held at the Annual Convention the adoption of the following resolutions:

Resolved, That the Board of Direction be authorized to ascertain whether suitable accommodations can be obtained for the Society in the proposed new building with provision for future needs [and also to make such investigation and hold such conferences as may bear upon the advisability of the acceptance of Mr. Carnegie's proposition by this Society].

Resolved, That the Board of Directors be authorized to coöperate to this end with the other organizations concerned.

Resolved, That the Board of Direction be requested, provided it is satisfied that suitable accommodations can be obtained, to send to the members of the Society a letter ballot by means of which a direct expression of the wishes of the Society in the matter may be secured, and to accompany such ballot by a statement of reasons for and against uniting in the scheme with the other organizations.

Resolved, That the Board of Direction, in case a majority of the members as shown by letter ballot are in favor of uniting with the other organizations, is authorized to proceed in behalf of the Society in carrying out the project.

A formal motion to adopt the resolutions recommended by the Board brought on a general discussion of the whole subject. The first speaker was Past-President John F. Wallace, whose opposition to the project has already been expressed in a letter published in Engineering News of May 21. Mr. Wallace said that the American Society of Civil Engineers is not a technical society. It is a professional institution. It has a valuable prestige which it must not jeopardize. Civil engineering embraces all branches of engineering work. We must not permit ourselves to be placed in the position of the remnant of the profession. We should not for a mess of pottage trade off our prestige. Thus, from the professional standpoint there appears nothing to be gained by the Society in the proposed change nor does any gain appear from the standpoint of expediency. We are on a firm financial basis. In a few years we will be debt free. We have ample accommodations. Our house is located satisfactorily.

The main reason advanced in favor of the change, said Mr. Wallace, is that it will centralize engineering interests; but he objected to any affiliation with the social and commercial Engineers' Club (applause). Divide the space in such a building by five and we will have less cubic feet of space than in our present building. "It seems to me that such an affiliation as has been proposed 'rubs something off the bloom of the peach.' I can see plainly how it may be desirable for these other engineering societies to have us help leaven their lump; but I cannot see why we should furnish the leaven."

Mr. Geo. B. Pegram, a member of the Board of Direction's Conference Committee, said that there appeared to be a general misconception among the members concerning the project. There is no question of union or consolidation or affiliation at all. It is simply a question whether this Society will join the other societies in the joint ownership and tenancy of a building. The Society can join or decline as it sees fit without reference to the other societies, as the others have decided to accept the scheme, and will do so without the Civil Engineers if they do not choose to join. Mr. Pegram then read a letter from Prof. Geo. F. Swain, of the Board of Direction, giving the results of a letter ballot taken among the members of the Society resident in Boston and vicinity, showing an overwhelming sentiment in favor of the plan (published in Engineering News of June 4). Prof. Swain also expressed his hearty approval of the project and earnest wish that it might be accepted by the Society.

Mr. Pegram also stated that competent counsel had advised the Board of Direction that it would be feasible to so frame an agreement that the financial interests of the Society would be protected in case the proposed coöperation were un-

dertaken. He also read a paper signed by some 30 prominent members of the Society urging the Asheville Convention to take such action that the Board of Direction may submit the whole question to letter ballot as soon as possible.

Mr. J. J. R. Croes then took the floor and presented an argument against the proposition, following in general very similar lines to those presented in his letter printed in Engineering News of May 28. After stating his own views of the matter, Mr. Croes proceeded to read letters which he had obtained from the eight survivors of the 19 engineers who revived the Society in 1867 after it had experienced several years of suspended animation. To each of these eight men Mr. Croes sent a letter setting forth the situation and requesting their opinion as to the policy which the American Society of Civil Engineers should adopt. The following are quotations in substance from these letters:

Hon. Thos. F. Rowland.—I am firmly of the opinion that it would be a dire calamity. I agree with you in all your adverse criticisms.

Mr. Chas. Paine.—Even if the proposed coöperation left the several societies entirely independent, the American Society of Civil Engineers would gain nothing that it has not now. The same sentiment that makes me prefer a separate home for my family makes me prefer a separate home for the American Society of Civil Engineers.

Mr. Mendes Cohen.—I can conceive no possible advantage to the American Society of Civil Engineers in the proposed alliance.

Mr. Geo. S. Green, Jr., and Mr. Henry G. Morris, of Philadelphia, each expressed opposition to the project. Mr. Edward P. North had always favored admitting the other professional societies to use of the auditorium in the present Society House, and he favored coöperative action by the four professional societies with respect to Mr. Carnegie's offer. He was strongly opposed, however, to any connection with the Engineers' Club, and thought that organization should be permanently segregated from the others. After the terms of coöperation have been arranged under competent legal advice, he favored submission of the question to the Society for decision.

Mr. Alfred P. Boller thought the project had much to commend it, and if properly carried out would result in great benefit to the whole profession. He thought, however, that absolute separation from the Engineers' Club was essential. Answering some of Mr. Croes' arguments, he thought that the younger men and changed conditions of the present day must be considered.

Mr. Croes also sent letters to the Past-Presidents of the Society. Mr. Thos. C. Keefer wrote that he agreed with Mr. Croes, and that the Society could not safely hold any property—not even a library—in common with other societies.

Mr. Robert Moore wrote that he was at first inclined to favor the plan, but now opposes it. He thought that merger of the library with that of other societies would be particularly undesirable.

Mr. Croes then turned to letters which he had received from other prominent members. Mr. Joseph P. Davis thought the move would be a fatal mistake. Mr. Charles Hermany was in doubt as to the proper course for the Society to take. Mr. Samuel M. Gray strongly opposed it. Mr. Charles MacDonald in his reply urged Mr. Croes to carefully investigate the possibilities of growth in the engineering profession before taking so strong a stand in opposition to the project. He thought that each society could maintain its individuality even when housed in the same building, and was inclined to favor the proposition.

Mr. Robert Cartwright, of Rochester, was opposed to the plan and had induced the other members of the Society resident in Rochester to join him in signing his letter. Mr. Francis Collingwood opposed the project. Mr. G. H. Benzenberg wrote that a great deal of consideration ought to be given to the subject. Mr. Rudolph Hering saw no fundamental difficulty in grouping all the societies under one roof.

In reading the above letters Mr. Croes interspersed various comments of his own. One point on which he laid especial stress was the distinction between commercialism and professional engineering. He would have nothing to do with societies of inventors and manufacturers and dealers in commercial articles. For example, at the convention of the American Water-Works Association there are large exhibits of water-works appliances and the sales agents are present in force. It would lower our professional prestige to have any such commercialism dominant in a house occupied by the American Society of Civil Engineers.

In conclusion, Mr. Croes thought that the Society ought to at once address a letter to Mr. Carnegie thanking him for his offer and for the spirit that prompted it, but stating that the Society, from the nature of its organization and its purposes, cannot consider association in any form with any social or commercial society.

By the time Mr. Croes had finished reading these letters the afternoon was far spent, and after Mr. Oberlin Smith had spoken a short time replying to some of the points raised by Mr. Croes, adjournment was taken to the following morning.

The evening session was devoted to the address of President Alfred Noble, which was printed in our last week's issue, on the development of Lake Commerce.

The convention reassembled on Wednesday morning and resumed the discussion of the union engineering house project. On the previous day the time had been nearly all taken up by those opposing the project, but Wednesday's session brought out arguments from those who favored it. Mr. H. S. Haines strongly deprecated the sarcastic expressions in the previous day's discussion respecting the other professional societies and the Engineers' Club. He was a member of the latter, had served on the governing bodies of both that organization and the Am. Soc. C. E., and could testify that the social standard set in the admittance of members was as high in the one as in the other. Referring to Mr. Croes' citation of opinions of the Society's founders, he remarked that the older members of the Society should not presume to decide the question. Their interest in it was very small compared with that of the younger members.

Mr. Fred. Brooks, of Boston, spoke of the strong sentiment of the Boston members in favor of the proposed coöperation and said he was profoundly impressed with the importance of cultivating fraternal relations with the other societies. Mr. Geo. W. Catt, of New York City, and Mr. R. W. Lesley, of Philadelphia, also expressed themselves strongly in favor of the project.

Past-President B. M. Harrod thought the scope of the Board of Direction's investigation of the project ought to be a little wider than was stated in the formal resolution which they had submitted, and that they should investigate the general merits and demerits of the scheme. After some discussion the clause printed in brackets in the above resolution was added to cover this point.

Mr. Henry B. Seaman said he had been from the beginning heartily in favor of a closer association of the Societies if it is practicable, or can be made practicable. He objected, however, to the attempt to unduly hasten the acceptance of the project and read his letter printed in Engineering News of May 14.

The discussion then turned on the time which should be allotted for the consideration of the project before its decision. After a general discussion a resolution offered by Mr. H. S. Haines was adopted as follows:

> Resolved, That it is the sense of this meeting that the letter ballot called for in the resolutions should be presented to the Society with the usual 60 days' notice and opportunity for discussion at the next annual meeting.

It will be seen that under the terms of this resolution the final vote of the Society upon the question cannot be taken until some time in 1904.

On motion of Mr. Chas. Hansel a resolution was adopted expressing to Mr. Carnegie the gratitude and appreciation of the Society for his generous offer, and stating that action would be taken upon it as soon as necessary arrangements could be completed.

TOPICAL DISCUSSIONS.

The first of the topical discussions was then opened, and Prof. W. K. Hatt, of the Bureau of Forestry, presented a paper describing the new series of timber tests which the Bureau is inaugurating. A notable feature of difference between these tests and those conducted by the Government several years ago is that in the new series it is proposed to make the tests on timber bought in the open market, whereas in the former tests all specimens were cut in the forest by the Bureau's representatives and were specially sawed for the work. Mr. A. L. Johnson, of St. Louis, who took part in the former Government tests, strongly criticised this feature of the new tests and urged that the earlier practice was the correct one.

The next topic set down for discussion was "Sewage Purification;" but Mr. Rudolph Hering, who was to open the discussion, was not present. A brief letter from him setting forth the present "state of the art" in concise shape was read, and no further discussion was offered. The morning session then adjourned.

The afternoon was devoted to a trolley ride around Asheville, visiting Riverside Park, a pleasure resort on the banks of the French Broad River. In the evening a reception was held in the hotel parlors at which the members and guests were presented to Hon. Chas. B. Aycock, Governor of North Carolina. The receiving party also included President and Mrs. Alfred Noble and Past-Presidents Harrod and Croes with the ladies accompanying them. After the reception, dancing continued in the ballroom until a late hour.

CONCLUDING SESSION.

At Thursday morning's session the proceedings were opened by a brief and witty address by Gov. Aycock, after which the following topic for discussion was taken up: "In the Treatment of the Mississippi River is the Levee Theory Justified by Experience?" Past-President B. M. Harrod, of the Mississippi River Commission, presented a carefully-prepared monograph, admirably presenting and summarizing the case for the Mississippi levees. Mr. Harrod said the critical point on which the question hinged was whether the bed of the river was rising and the channel capacity decreasing as a result of levee construction or whether an opposite result was taking place. He reviewed the careful and impartial work of the Mississippi River Commission in collecting evidence to determine this point. It can only be determined by the most intricate and complicated investigations, and those who presume to offer an opinion on this point based on mere knowledge of local conditions only betray their ignorance of the problem.

In 1881 to 1883 and in 1894 to 1896 the Commission had detailed surveys made of the entire Mississippi River, from Cairo south. A comparison of these surveys shows that the trend of change is toward a channel more uniform in depth and of greater capacity. Comparison of low-water gage heights is also valuable since changes in low-water heights may reveal elevation or depression of the river bed. These comparisons indicate a deepening of from ¾-ft. at Fulton to nearly 2 ft. at Lake Providence.

Continuing, Major Harrod showed that both the reservoir scheme and the outlet scheme advocated by the opponents of levees rest on false and absurd assumptions, and that the only course open for the better protection of the alluvial basin of the Mississippi from overflow is to extend and perfect the present level system.

Mr. John A. Ockerson, of the Commission, sent a written discussion following lines similar to that of Major Harrod and further supporting his conclusions. Written discussions were also contributed by Messrs. L. M. Haupt and L. W. Brown, but as the hour was late, reading of these was omitted.

"Is it Possible to Make Concrete Which Will be Impervious to Water? If so, What is the Best Method?" This subject led to fruitful discussion, participated in by R. W. Lesley, J. J. R. Croes, J. W. Schaub, Bernard R. Green, Oscar Lowinson, Jas. H. Harlow, W. K. Hatt and others. Some of the points brought out may be summarized briefly as follows:

Wet concrete is less porous than dry concrete. Rich concrete is less porous as the proportion of cement is increased. A floated or troweled surface is tighter than one made against a mold. By mixing about 1% of alum and of soap with the concrete, the pores are filled and a substance more

waterproof then ordinary concrete is produced. Silicate of soda (water glass) has a similar effect but decreases the strengeh about 50%, while alum increases the strength about 50%. The water tightnesss of concrete depends upon the head. The French engineers in using concrete water conduits strengthened by iron or steel rods use a steel plate lining where the head exceeds 50 ft. Various coatings may be applied to waterproof the surface of concrete; but such coatings are easily ruptured and cracks are bound to occur in any considerable surface of concrete through which water can gain free entrance. In using concrete-steel, water-proofing the concrete is necessary or water will rust the steel and eventually destroy the structure.

Toward its close the discussion drifted onto the question of concrete-steeel, which was indeed the next topic set for consideration, and a resolution was adopted as the sense of the meeting that a committee should be appointed to investigate the general subject of concrete-steel. Under the Society's constitution, a large snarl of red tape must be unraveled before such a committee can be appointed; and the action of the Asheville convention is merely the insertion of the very thin end of a very long wedge to bring about the creation of such a committee.

"In View of the Increasing Weights of Rolling Stock, for What Loadings Should Railroad Bridges be Designed?" This interesting topic was opened by a paper sent by Mr. Henry W. Hodge. He remarked at the outset, apropos of the tendency of railway officers to build only for the present, that he had known recent railway bridges to be strained 33⅓% beyond the loads for which they were designed within only two years after their completion. He saw no sign of an end to the increase in weights of rolling stock except from the clearance limits of the roadway and the supporting power of the earth roadbed. While the loads of freight service may be the greatest, the impact of modern passenger service causes most injury to the permanent way. He had recently been assured by a competent engineer, familiar with railway rolling stock, that it would be impossible to increase the present maximum axle loads in railway service over 15%. On this basis Mr. Hodge had computed that the maximum bridge loading of the future on railways of heaviest traffic might be assumed to be two locomotives each with 260,000 lbs. on drivers or 400,000 lbs. in all with tender, followed by a train weighing 7,000 lbs. per lin. ft.

In conclusion, he pointed out that while it would be greatly for the interests of the railway companies to build their bridges with provision for the future loadings, the present system in which a bridge is built only strong enough for present loads and must be replaced in a few years is an excellent thing for the bridge builders and designers.

Mr. J. W. Schaub said he knew of bridges which have members carrying double the stress for which they are designed and which are nevertheless perfectly safe. Both he and Mr. Emil Swensson thought that where the heaviest rolling stock is run, the supporting power of the earth roadbed is a more important matter than the bridges. Mr. T. E. Condron called attention to the fact that in fixing unit stresses of members the effect of impact produced by moving loads is of greater importance than has generally been considered.

This closed the technical discussion, and after a committee had been appointed to draft resolutions of thanks to the members of the local committee and others who had contributed to make the Asheville convention a success, the final adjournment was taken.

In the afternoon an excursion was taken over the Asheville & Craggy Mountain R. R., by invitation of Mr. R. S. Howland, the President of the company owning the line. A paper descriptive of the road, prepared by Mr. R. H. Tingley, M. Am. Soc. C. E., and was distributed to the members. The railway is an electric road running from the terminus of a branch of the Asheville Street Ry. up the side of Sunset Mountain to an elevation of about 2,875 ft. above sea level and some 600 ft. above the city of Asheville. The line was originally built in the early '90s to be operated by a dummy steam lecomotive, but it was a financial failure and was abandoned in 1893. In 1900 it was rebuilt for the use of electric traction. The line is about 2¼ miles in length and has an average grade of 3.24% and maximum grades of about 5½%. The line has one switchback and curves as sharp as 150 ft. radius are used. Speeds are limited to about 6 miles per hour in ascending and descending.

From the top of the mountain a magnificent view is had of Asheville and the surrounding country with the distant group of mountains and the French Broad Valley stretching to the northwest. Through the courtesy of Mr. Howland a barbecue luncheon was served at the pavilion on top of the mountain, after which the return trip to the hotel was made. In the evening a "Southern Plantation Entertainment" was given in the hotel ballroom.

On Friday morning the closing event of the convention and in many respects the most enjoyable took place—a drive through the famous Biltmore estate of Mr. Geo. W. Vanderbilt. The day was the finest in point of weather conditions of the entire stay in Asheville, and a cavalcade of some thirty or more carriages conveyed the party from the hotel through the town and over the magnificent drives of Biltmore. As a piece of landscape architecture and particularly of the cultivation under natural conditions of Southern flora the Biltmore estate is probably unequaled anywhere. The wealth of colors and odor in the thickets of laurel, and rhododendron and honeysuckle and wild rose and the fine healthy groves of Southern trees were a revelation to the visitors, and the pleasures of the visit to Biltmore will be long remembered by every one who took part in it. In the afternoon the convention broke up, most of the members departing on the afternoon trains, although a few remained until the following day.

All told, the Asheville convention was a notable success, and for this much credit should be given to the labors of Col. J. L. Ludlow and his associates on the Local Committee, who spared no endeavor to further the pleasure and comfort of the visitors.

MOLDING MACHINES OF THE "SQUEEZER" OR HAND PRESS TYPE.*

By S. H. Stupakoff.†

The object of machine molding is to save labor, to increase the output of a foundry, to decrease the cost of production, to produce uniform and, if possible, better castings than can be produced by hand, and to employ the smallest possible amount of skill in those particular molding operations, which comprise a series of ever repeated automatous movements.

It is obvious that it would require a complicated mechanism to perform successively and successfully all the necessary operations to make a complete mold, even if it were only the mold of a simple pattern. In consequence the general equipment of a foundry, which accomplishes this object, must be necessarily quite an elaborate and expensive matter. The majority of designs of molding machines run in this direction, whereas, in most cases it would have been better if the energy expended had been directed to their simplification. Such tendencies lead to complications, which are altogether unsuited for foundry practice; they meet with little favor and machines built upon these principles are of short life. Only the simpler molding machines have a chance of meeting with more or less success, even if they perform but a few operations, providing they perform these well. Many founders would be well satisfied if at least some of the more expensive operations could be performed satisfactorily with the aid of time saving machinery. With this object in view, some ingenious founder or molder originally devised a contrivance to withdraw his patterns from the mold by mechanical means. Accessible records show that this occurred at least during the first half of the last century. The next step was to employ stripping plates, and conjunctively therewith it was attempted to ram the mold by machinery. These two operations, i. e. withdrawing the patterns from the sand, and ramming the flask, are the basic principles of all molding machines. Some machines are constructed to perform the one, some to perform the other operation and still others combine both in the same apparatus. All subsequent improvements and additions, and all variations and methods of construction are merely a matter of detail. However, it must be said that it is solely due to the judicious selection and arrangement of these very details, and to the superior refinement and quality of workmanship employed in their construction, that modern molding machines have actually become a success.

It would be idle to enter into a detailed description of the long series of schemes which have been suggested, and which have been patented in this and in other countries. Some of them seem quite feasible and some of them have been successfully put in operation; but the majority are more or less impracticable and not worth the effort expended thereon. In the following only the type of each group will therefore be presented, and occasionally a description of the more important parts will be given; but we shall dwell at length upon the construction of those machines which have found favor with our foundrymen, and which, be it through merit or push, have found introduction and gained a strong foothold in many of our modern foundries.

CLASSIFICATION.—Molding machines may be divided into two large groups according to the manner in which they are operated, that is into hand and into power machinery. The former may be made stationary or portable, each class being adapted to the peculiarities of existing conditions and requirements. Stationary machines may be distributed to good advantage along the walls or in rows along the aisles of a molding floor; quite frequently they may be secured to benches or posts or to the walls of the foundry. In other instances they may be advantageously provided with individual stands. The selection from these arrangements depends mostly upon specific circumstances, and little can be said against or in favor of one method or the other. Portable machines may represent the identical details of construction in their mechanism as stationary machines, but they are always provided with individual stands on wheels, which admits of their being easily rolled from place to place, following the sand heap and the flask pile on the foundry floor, and leaving the finished molds behind them.

Portable machines are good in their place, but they are not good in all places. Molding machines can be made portable only in cases where they are operated manually, and economy by portability decreases as the size and weight of the machine increases. Machines driven by power depend more or less upon fixed positions, and cannot be moved about. It is of course an object well worthy of careful consideration in all cases to save time and labor in handling the molding sand, the flasks and the finished molds; but other means than portability on the part of the molding machines must usually be resorted to, to attain the desired results.

HAND PRESSES.—The simplest form of all molding machines is undoubtedly the "squeezer." As its name implies, it serves the purpose of "squeezing"—not ramming—the molding sand into the flask. This object is accomplished by applying pressure to a plunger which is provided with a suitable press board, and compacting the sand in the flask by this operation. Properly speaking it is therefore a plunger press, or a plunger molding press.

The flask with follow or molding board and patterns is usually placed on a platen or table, and either the plunger is moved downward or the platen with the flask is moved upward. In exceptional cases the plunger or plungers move horizontally. Either one of these arrangements accomplishes the end, but satisfactory results depend largely upon the details of construction of the respective machines.

In most cases the pressure is applied by compound leverage, which, as a rule, admits of the simplest and most effective design. The moving portions of such machines, which are continuously exposed to the erosive action of the molding sand, and which, on this account, are subject to considerable friction and much wear, may therefore be made exclusively of pin connections. These are less expensive, and when worn easier replaced, than the parts of any other mechanical movement.

HAND PRESSES WITH OVERHEAD MECHANISM.—The most effective squeezer is one with the most powerful and most sensitive leverage, which requires little muscular effort and which confines the movements of the operator within a small compass. It appears further, that it would be of best advantage to arrange all moving parts of a molding machine above the flask, as in this manner they will be removed from the direct influence of the sand. Such an arrangement would give little opportunity for wear and tear, few interruptions in service, and a minimum of repairs.

This principle was followed in the construction of the post press, illustrated in Fig. 1, wherein the entire mechanism is arranged above the flask. The leverage here consists of a toggle joint which is operated by toothed eccentric segments. One of these segments forms an integral part of the combination counterweight and hand lever, and the second one is pivoted to the head of the plunger, which carries the press board at its lower end. Both segments are connected by a double link, which not only keeps the teeth of the segments in proper mesh, but which at the same time serves as a member of a toggle joint, of which the arm of the lower movable segment is the second member. The eccentric arrangement of the gear segments imparts a quick movement to

*Abstract of a paper read at the annual convention of the American Foundrymen's Association at Milwaukee, Wis., June 9-11, 1903.

†Pittsburg, Pa.

the plunger at the upper period of its stroke and multiplies the power applied at its lower period.

The mechanism is well designed, and comprises but few parts for the purpose it accomplishes. But it seems that the length of the stroke, depending upon the nature of this construction, is rather limited, and it is questionable whether the moving portions in spite of their dust proof covering are not subjected to the cutting action of unavoidable dust. This machine, as found in the market, is either secured to a stationary post, and in this case it

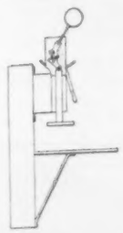


Fig. 1. Molding Machine with Overhead Mechanism Mounted on Stationary Post.

Fig. 2. Molding Machine with Overhead Mechanism Mounted on Carriage.

is provided with a bracketed shelf below the plunger head, which serves as a support for the bottom or mold board and flask (Fig. 1); or it is mounted on a movable frame as illustrated in Fig. 2.

HAND PRESSES WITH -UNDERLYING MECHANISM.—A second group of plain hand presses embraces all machines which have their mechanism arranged below the table, or respectively the flask. We meet here with numerous designs, which embody almost without exception the application of compound levers. Molding machines belonging to this class are operated in three different ways, namely: by forcing the pressure head downward, or by forcing the mold upward, or by moving both portions toward each other.

Economical reasons prescribe, that the pressure head should only occupy its central position with regard to the position of the flask on the machine table during the performance of its function. At all other times it would act as an obstruction and it should be taken out of the way during the placing of the flask on the machine, the filling of the same with molding sand, and its removal after completion of the mold. This is accomplished by either pivoting the pressure head uprights to the base of the machine, or by swinging the head horizontally in journals around a vertical post, or by sliding the table or the pressure head in guides in a straight line in one direction or the other. These three principles are illustrated in Figs. 3, 4 and 5, which require no further explanation.

This movement ordinarily requires a special manipulation by the operator, which is not seriously objectionable, especially if the head is counterbalanced, be it by weights or by springs. The designers of some machines prefer to accomplish this movement by means of the main hand lever, which perform the act of pressing. And naturally, by doing it in this manner, it can be done only at the expense of the length of the stroke, which is hereby in some cases quite unduly increased. It is quite an important matter in hand operated machines, that the length of the stroke of the main lever be kept within as small a compass as possible. By increasing it the bodily exertion of the operator will be increased likewise, and the output or the capacity of the machines will suffer materially.

Particular attention of designers, manufacturers or purchasers of such machines is directed to the importance of confining the motions of the operator within the smallest possible limits. He should remain permanently in an upright position, he should have no occasion to stoop or to excessively bend his body; he should be able to perform the bulk of his work by using only the muscles of his arms, adding thereto occasionally the weight of his body, if this should be necessary. If these rules are strictly followed, it is reasonable to suppose that the best possible results can be expected.

It is necessary that the distance of the pressure head from the table should be made variable, that it may accommodate itself to the height of the flask, which varies with the particular piece of work on hand. This is easiest accomplished by means of adjusting nuts placed on the uprights above and below the pressure head, as shown in Fig. 3, or by raising and lowering the pressure head column in machines of a design as Fig. 4. Makeshifts, obtained by piling up additional boards on top of the pressure board, which practice is frequently resorted to, require too much handling, and are costly, uneconomical and unadvisable.

MACHINES WITH MOVABLE TABLE.—Figs. 6 to 8 illustrate several types of levers applied to hand presses with underlying mechanism, which are operated by raising the table with the flask, in this manner forcing it against the vertically fixed pressure head. The drawings at the same time illustrate different modes of guiding the table in its support. The position of the pressure heads is indicated by dotted lines. Fig. 6 shows the positions of the mechanism in its normal position in full lines and in its reversed position in dotted lines. The drawings in which all details have been purposely omitted, are self-explanatory; their object is to particularly show the manner of raising the table and flask by the reversal of the upwardly extending hand lever, which is directly connected to a shaft that carries either cranks, levers, cams, eccentrics, pinions or any other suitable contrivance which engage with the downwardly extending shaft or stem, or shafts or stems, of the table.

MACHINES WITH MOVABLE PRESSURE HEAD.—A second principle for applying pressure to the mold in plain hand presses is illustrated in Figs. 9 and 10, which show the usual method employed for pulling the head downward against the mold. The pressure head uprights are in this case preferably arranged as in the foregoing, that they may be swung backward, and for this purpose their lower ends terminate in eyes which are movably fitted to pins. These pins, studs or shafts are arranged to slide vertically in slots or guides of the frames or standards, and they are either directly or indirectly connected to a hand lever. The normal position of the latter is towards the rear of the machine, and the upward or raised position of the pressure head corresponds with it, while its reversal causes a downward movement of the head and upon application of muscular force a corresponding pressure upon the mold.

It will be observed that the arms of the knee lever in Fig. 9 swing around a fixed center, which forms part of the frame work, and that in this case the end of the shorter arm is connected by a link to the base joint of the pressure frame, while in Fig. 10 the end of its shorter arm is jointed to a movable link, which is journaled at its upper end to the frame, whereas the boring at the apex of the angle engages directly with the pin of the pressure frame. Other means are employed to accomplish the same results and to take the place of those which have here been shown and described, but they are mostly even more complicated and offer no additional advantage.

MACHINES WITH DOUBLE FUNCTION HAND LEVERS.—We will now turn our attention to Figs. 11, 12 and 13, which show the combination lever movements of a well-known molding machine which combines the forward movement of the pressure head with its downward movement towards the mold. The arrangement of levers varies but little from that shown and described in the foregoing, but by securing the fulcrum of the hand lever above the fulcrum of the vertically movable pressure head uprights, and connecting its short angular arm to a link which engages with the uprights above the two mentioned fulcrums, an additional function of the leverage is attained. This acts so that the first portion of the stroke of the hand lever swings the pressure head forward and in this manner brings it into a vertical position against a stop. A further movement causes it to descend vertically toward the table of the machine. A counterweight, acting upon a crank-like bent shaft which is secured to the lower fulcrum of the pressure head uprights assists in raising the head when the lever is reversed, and in bringing it back to its normal position.

It is an unlucky coincidence that with this arrangement at the very moment when the greatest power is required for compressing the sand, a part of it is spent to raise the counterweight to its uppermost position. This, however, is partly offset by the fact, that at the end of this portion of the stroke the lever is in the most favorable position for the application of pressure, as the operator may use the maximum stress of his arm muscles, and add his own full weight to effect its depression. On the other hand again, it should be noted, that nearly 90° or two-thirds of the entire stroke of the hand lever is required to bring the pressure head from the rear to its central position; and this is a proceeding which

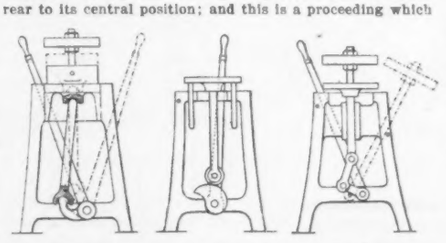


Fig. 6. Fig. 7. Fig. 8.

Figs. 6-8. Types of Molding Machines with Movable Table.

does not deserve particular recommendation. On the whole, however, it must be said, that the combination of this leverage is an economical arrangement, which accomplishes its purpose without the expenditure of much power, and causes but little inconvenience and fatigue to the operator.

Figs. 14 and 15 illustrate the leverage of another style of hand press which accomplishes the object just described, but in a different manner. The hand lever of this machine is arranged independently from the pressure head uprights; both swing in independent centers; the hand lever engages with these uprights indirectly, by the interposition of supplementary levers, and such engagement continues only during the first portion of its stroke; it disengages after it has brought the pressure head from its normal into the vertical position; the pressure head is stationary with relation to the flask, while the table with the flask moves upward toward the pressure head, all of which is contrary to the arrangement as described in the foregoing.

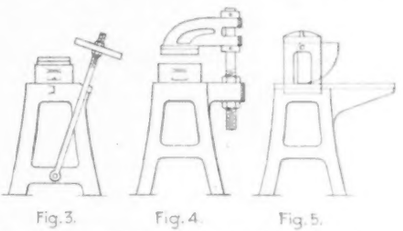


Fig. 3. Fig. 4. Fig. 5.

Figs. 3-5. Types of Molding Machines with Underlying Mechanism.

The supplementary levers are two-armed; they are secured to the machine frame by studs which serve as their fulcrums. The end of one arm of each of these levers is slotted or fork shaped, and fixed studs or pins, placed in corresponding positions in the hand lever and in the adjoining pressure head rod enter the slots. The second pair of arms of these levers are provided with a stud in one, and a cam shaped groove in the other. Both are linked together by these means, and their relative position governs the position of the pressure head. The normal state of things is illustrated in Fig. 14, which shows the machine at rest, and the reversed state, showing the position of the levers, after pressure has been applied is given in Fig. 15. It will be observed that the engagement stud of the hand lever enters the open end of the slot in the fork-shaped cam lever during its backward movement, and in following the curve of this slot it causes the pressure head upright to be forced backward. The hand lever engagement stud will rest at the lower end of the cam lever slot, and the table and flask will have returned to their original position of rest, when the pressure head arrives at its final inclined position.

A close scrutiny of the merits and demerits of this arrangement cannot fail to reveal the fact, that the moving parts of this machine are too much exposed to the injurious action of spilled sand, and there is no possible way of effectually guarding against it. The slots and the groove in the cam have sliding faces, which are exposed, and which must be exposed to admit of a free ingress and egress of the engaging studs, and all these are open to the free access of dust and molding sand.

A combination of the mechanical movements of the main lever and the pressure head may appear at first sight as a preferable and superior arrangement. The simultaneous or connectedly consecutive movements of both, however, offer but little advantage in general. And, should it be the case, that the inappreciable gain be offset by other objectionable features, as by the troublesome task which arises from the compulsory frequent cleaning of moving parts, and from subjecting these to excessive wear and tear, it would seem better and cheaper in the end to adhere to the simpler constructions, and move each portion separately and independently from the other.

These remarks should not be construed prejudicially against any particular construction, they merely express an impartial view of the subject, which is based solely upon facts and close observation. They may serve to throw light at some of the faults which are usually encountered in all molding machines, and they refer with equal force to designs as illustrated in Figs. 11 to 13, where exposed slots in the frame act as guides for the vertical movement of the pressure head. Though, in this particular case, a close fit is not very important, the necessary precaution should have been taken to prevent an accumulation of molding sand about the sliding portions as well as at the bottom of the slots.

SCOPE OF PLAIN HAND PRESSES.—It requires very little reasoning to prove that the scope of utility of the described forms of "squeezers" encompasses but small limits, and that their successful application is strictly confined to the molding of shallow patterns. Unless in the case of deep patterns ordinary hand ramming and peining is resorted to at least for a part of the operation of compacting the sand, the simple manipulation of the flat bottom pressure head will give but a poorly packed mold, which cannot possibly result in satisfactory castings. It is liable to give rise to all sorts of trouble. The casting may not come out true to size or true to pattern; it may be swelled and rough in one place and not run full in another; the molding sand which has not been rammed sufficiently hard in places may be washed off by melted metal, and as a consequence the casting may come out dirty and be unfit for use. Many other objec-

tionable features may result, which would condemn not only the casting but also the molding machine itself.

It is well known that patterns of different characters require different treatment at the hands of the molder, and that it takes the combination of good judgment and skill, only to be acquired by long practice, to make molds of various intricate shaped patterns which will always produce good castings.

It is a grievous mistake to think that a molding machine of any description will replace a skilled molder. There is no less ingenuity required to produce good castings on a machine than to make them by hand. A molder is aided by his experience and by his good judgment; a machine hand (customarily selected from unskilled labor) has nothing to offer but his muscles and his good will. These qualities, however valuable they may be in some places, are at best but poor substitutes for the dexterity of an expert. This being the case, it is quite natural, that under ordinary circumstances the chances are but slight to obtain good castings and good general results by mechanical means which are imperfectly understood, and subjected to reckless abuse by hands which

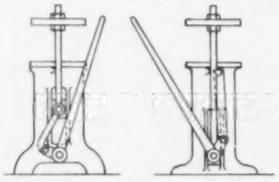


Fig. 9. Fig. 10.

Figs. 9 and 10. Types of Molding Machines with Movable Pressure Head.

are unquestionably green in the business. And, if it were for no other purpose than to avoid loss and failure, this should be sufficient reason to provide if possible the necessary means to counterbalance all, and where this cannot be accomplished at least the greater part of the shortcomings of this method. Owners of molding machines should not expect marvels from an inert piece of mechanism; but it is safe to say they will seldom fail in their calculations, if they are satisfied with a reasonable increased production, provided they are willing to pay the best possible attention to their manipulation.

THE SUBSIDENCE OF THE LAND AND OF THE HARBOR BOTTOM AT BOSTON.

When a thorough-going engineer, content with nothing short of all available underlying facts, enters upon an investigation, there is no knowing what additions to scientific knowledge he will make ere he finish his studies. As an example, we have before us advance pages of Appendix No. 20 to a report by Mr. John R. Freeman, M. Am. Soc. C. E., of Providence, R. I., on the proposed Charles River dam, designed to form a water park and otherwise improve Boston and vicinity. Here are 44 closely-printed but readable pages, headed with the statement that "Boston is Slowly Sinking into the Sea, and the Harbor Bottom Tends to Slowly Become Deeper."

Mr. Freeman opens his discussion with the following interesting statement of his conclusions, his proof thereof, and the reasons which led him to enter upon this investigation:

All of the territory in and about Boston is probably slowly sinking relatively to the level of the sea. Apparently this subsidence is at the rate of about 1/16-in. per year, 1 in. in eight years, or a little more than 1 ft. in each 100 years.

This is obviously a question of great importance in comparing ancient soundings with modern, and in considering the possible future shoaling of the harbor.

The present datum plane to which all elevations are referred by the engineering department of the city of Boston, and which is commonly known as "Boston base," probably coincided almost exactly in the year 1830 with mean low water at the Charlestown Navy Yard. Prior to the Miner levels of 1878 the Boston datum had always been supposed to be at mean low water, and was so marked on the plans made by the city up to 1878.*

In 1878 Boston base was found to be about 0.64 below mean low water as determined by the United States Coast Survey at some time just prior to 1870.†

To-day, after the lapse of 72 years, this same datum plane, as defined by numerous bench marks on solid ground, according to the best available determinations, is 0.79 ft. below mean low water.

This comparison shows that the land now stands about 0.79 ft. lower relatively to the sea than it did about 72 years ago, and therefore shows that the land in Boston and vicinity is sinking at the rate of about 1 ft. per 100 years.

Making a similar comparison on the basis of mean sea level, instead of mean low water, we find the rate of change is 0.71 ft. in 72 years.

This change affects a very large area, and a variety of independent proofs is offered.

At this rate the present grade of Atlantic Ave. near the foot of State St. (15.0 Boston base) will be awash by the spring tides of each month about 250 years hence.

The proofs of this subsidence will be presented in detail in the following pages. These proofs in brief are:

(1) The sills and floor of the masonry dry dock at the Charlestown Navy Yard now stand about 9 ins. (0.71 ft.) lower relatively to mean sea level than they did 72 years ago, while the dock stands at precisely the same level relatively to points on solid ground.

(2) The comparison of sundry tide gages, ancient and modern, indicates progressive subsidence.

(3) Many rocks about the edges of Massachusetts Bay are found to be from 1 to 2 ft. deeper below extreme low water now than they were about 90 years ago.

(4) The extreme tides in great storms appear to show progress toward greater heights.

(5) At many points about Boston tree trunks are found standing in salt marsh under conditions that prove a recent subsidence.

I was led to investigate this matter by consideration of statements of Prof. W. O. Crosby regarding the geological causes which had formed Boston harbor, resulting in a submerged valley; and from my observation of the peculiar relation of the present datum plane at present used by civil engineers on the Boston public works, known as "Boston base," to the ancient datum plane of "marsh level" and to "mean low water," and because of the unsatisfactory explanations offered as to why "Boston base" was established at the odd distance of 0.64 ft. below mean low water, I was led to investigate the old bench levels.

I had for some years past been interested in the indication of comparatively recent subsidence found in the resemblance of some of our coastal indentations to ordinary valleys that had become submerged, and in studies as to the future water supply of Brooklyn (Report on New York Water Supply, 1899-1900) I had occasion to review the proofs of recent subsidence offered by the state geologist of New Jersey, and was therefore the more ready to follow out the indications of the present case.

One reason why the lowering of the sills and floors of the Charlestown dry dock was not discovered sooner, Mr. Freeman believes, is that this change in level was "offset and obscured" by the lifting of the dry dock wall 0.20-ft. in the 29 years of continuous tidal observations at this point from 1847 to 1876. Mr. Freeman believes that since the wall was built (the coping was completed in 1831) the "old standard Coast Survey bench mark (thereon—Ed.) has beyond all doubt or question lifted nearly 6 ins." Another "Example of Increase in Height of a Heavy Masonry Wall Alongside of Water" is thus given by Mr. Freeman:

I had occasion to make a careful investigation of some discrepancies in supposedly precise levels upon structures connected with the dam and the canal head gates at Lawrence 22 years ago, which resulted in positive demonstration that the top of a heavy masonry wall 21 ft. in height, founded on ledge and serving as a retaining wall of the north canal, close to the head gates, upon which a monument had been cut in 1847 to serve as a standard for precise levels for use in the building of structures along Lawrence canals, had progressively risen 7/8-in. in the course of 34 years, without any noticeable cracks or other distortions having been produced.

In tracing out the original levels, another excellent monument cut on the solid ledge only 60 ft. distant was found thinly covered with earth, which had originally served as a standard, and had been abandoned for more convenient location on the masonry retaining wall. The finely cut crest of the solid masonry dam and the finely cut granite masonry sills of the sluice gates, which were cemented into solid ledge and had never been exposed to frost and were easily reached by emptying the canal, gave excellent independent comparisons, and it was found:

From 1847 to 1881 the wall bench mark rose by comparison with bench mark on ledge 60 ft. distant .071 ft.

By comparison with masonry sills of the sluice gates, which were cemented into channels cut in the solid ledge and had never been exposed to frost, it had risen .08 ft.

By comparison with crest on end of masonry dam it had risen .074 ft.

Other levels were found which proved that in the first two years from 1847 to 1849 it rose .010 ft., and that in the first seven years from 1847 to 1854 it rose .030 ft.

Mr. Richard E. Hale, C. E., principal assistant engineer, Essex Co., at my suggestion, within the past few weeks, has made another series of comparisons with the original bench mark on ledge, and finds that in the 22 years since my comparisons noted above, it has risen the further distance of .022 ft., so that it now stands .093 ft. higher than originally, 56 years ago.

After this careful investigation of 22 years ago, it was concluded by Mr. Hiram F. Mills, chief engineer, and myself that this rising had doubtless been caused by action of frost on water in the joints of the masonry, which had lifted along many microscopic cracks, and that when the ice had melted fine sand had silted in, thus blocking it from returning exactly to its original position.

Careful measurements of the scales of feet cut into the masonry of the dry dock show that wherever two of the adjacent footmarks are cut into the same stone, they are precisely 1 ft. apart, but, excepting near the bottom, wherever a joint intervenes this distance between the marks is increased, often by 1/2 or 3/4-in.

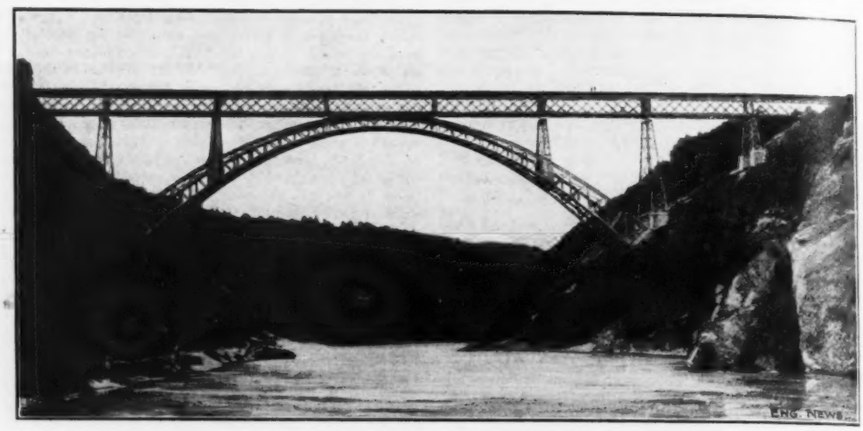


FIG. 1. THE PADERNO WROUGHT-IRON ARCH VIADUCT OVER THE RIVER ADDA, NORTHERN ITALY.

Societe Nazionali di Savigliano, Turin, Italy, Builders; Mr. G. Rothlisberger, Chief Engineer.

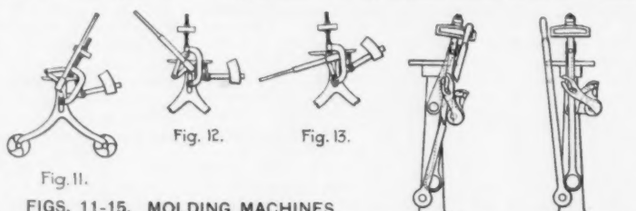


Fig. 11. Fig. 12. Fig. 13. Fig. 14. Fig. 15.

FIGS. 11-15. MOLDING MACHINES WITH DOUBLE FUNCTION HAND LEVERS.

*See city engineer's report, 1899, City Document No. 14. The Miner bench levels of 1878 made the old Coast Survey bench mark 15.33 by Boston base, starting from sundry old benches in the city proper which were found in substantial agreement.

The coast survey report of 1870, p. 93, gives the height of this bench mark as 14.69 above mean low water, 15.33 −14.69 = 0.64 ft.

†There is some uncertainty in this comparison because of lifting of old bench mark by frost.

The U. S. Coast Survey, after detailing Mr. H. L. Marindin to investigate the subject, does not yet admit the subsidence claimed by Mr. Freeman, a fact which the latter believes is at least partly due to a failure to give "reasonable attention to the plain evidence" presented regarding the lifting of the bench mark.

The made land in the Back Bay district has a settlement of its own, due to "compression and squeezing out of the water in the earth," which is "entirely distinct from the general subsidence of bed rock and all" discussed in the appendix. In some districts a settlement of 1 ft. in 30 years is noted. This of course renders all Back Bay bench marks uncertain, but nevertheless it is stated that, to save two miles of leveling, the line run from Boston to Albany, in 1893, by the Massachusetts State Topographical Survey, was started from a bench mark on the Museum of Fine Arts, located on this same made land.

We shall not attempt to follow the detailed proof of subsidence along the five lines stated in the first quotation here given. It shows a wide range of research, and includes much interesting information regarding early surveys and engineering works. It also shows, as Mr. Freeman suggests, the need of more precise records by future harbor commissions, by sewer departments and city engineers in and near Boston, and of "a better and more permanent series of standard benches" throughout the metropolitan district.

THE PADERNO WROUGHT-IRON ARCH VIADUCT, ITALY.

The Paderno Viaduct over the River Adda is one of the most important Italian bridge constructions of recent years. In length of span this arch ranks considerably below a number of the large arch bridges of America and continental Europe, but it is of interest in comparison because it is without hinges and is built of wrought iron instead of steel, and also because of the method of erection adopted. The bridge platform is also a double-deck structure carrying a highway above and a single track railway line below. For illustration we have selected a general view of the completed bridge; a cross-section through the arch ribs and platform, and an elevation and transverse section of the elaborate falseworks and service viaducts employed in erecting the iron-work. These illustrations have been taken from the "Engineer," of London, England, and we are likewise indebted to that journal for the facts from which our description has been prepared.

The Paderno Viaduct, Fig. 1, minus the masonry abutment approaches, has a total length of 871 ft. 2 ins., divided into eight lattice truss spans of 108 ft. 10¾ ins., carried by three viaduct towers, two arch towers, and three points of support on the arch ribs. The masonry abutment approaches are each 62 ft. 2 ins. long, making the total length of the bridge 995½ ft. The arch span is 492 ft. long between centers of skewback bearings, and has a rise of 129 ft. The height from water level to the top of rails is 242½ ft., and the upper deck is some 25 ft. higher than this. The viaduct serves a single track line of the Meridionali Ry. Co. and the new provincial road recently constructed by the provinces of Bergamo and Como.

For the purpose of brief description the viaduct may be divided into three parts; the arch span, the towers and the platform spans. The substructure and foundations call for no particular mention. The abutments, piers and skewbacks are of coursed stone masonry founded at small depth on the very compact gravel conglomerate which forms the sides of the gorge.

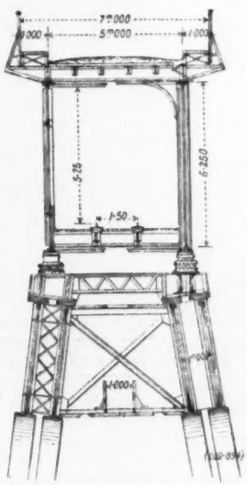


Fig. 2. Transverse Section of Paderno Viaduct Near Crown of Arch.

ARCH SPAN.—The arch span is composed of two ribs spaced 56 ft. 3 ins. apart at the skewbacks and 16 ft. 4 ins. apart at the crown. Each rib consists of two parallel trusses spaced 1 m. (3.28 ft.) apart. Each truss is composed of built-up chords of T-section connected by a web system of N-bracing, and the two trusses are connected to form a rib by means of transverse latticing in the planes of the web members. The two ribs are braced together by sway bracing in the planes of the vertical web members of the trusses and by top and bottom lateral systems in the planes of the curved chords. The bottom lateral bracing also serves to carry midway between ribs a narrow footway for inspection purposes. The arch ribs are without hinges. At the skewbacks they are carried by steel shoes anchor-bolted to the masonry.

TOWERS.—The towers which carry the platform trusses are all alike in general construction. Each consists of four legs braced together by horizontals and X-braces in the four planes of the legs. The land towers are carried on masonry pedestals, and the highest of them, namely the two located just back of the skewbacks, are 163 ft. high and have a transverse width of 56 ft. 3 ins. at the bottom and of 16 ft. 4 ins. at the top. The arch towers rest on wrought-steel pedestals carried by the arch ribs, which are locally reinforced to receive them, as shown by the general view, Fig. 1, and the transverse section, Fig. 2. At the tops the four legs of all towers are bound together by heavy open web girders which carry the cast-steel seats and expansion bearings for the platform trusses.

PLATFORM SPANS.—The platform spans consist of two lattice trusses spaced 5 m. (16·4 ft.) apart, and having a clear inside width of 15 ft. The chords are built-up T-sections and the web members are flat bars. The railway track is in the plane of the bottom chords, the floor system consisting of transverse beams spaced 10 ft. apart and carrying a line of stringers under each rail, with the openings between filled with a flooring of channeled sheet iron. Longitudinal timbers over the floor stringers carry the track rails. The roadway platform in the plane of the top chords consist of transverse floor beams spaced as in the deck below, and carrying four lines of stringers on which is a trough floor filled above with macadam. On each side of the roadway there is a sidewalk carried outside the trusses by plate brackets and protected by hand railings. A system of angle lateral bracing connects the two trusses in the plane of each chord. The main dimensions of the platform construction are given in Fig. 2.

ERECTION.—The erection of the viaduct was accomplished by means of an elaborate system of falseworks and service viaducts. These are shown in elevation and section by Fig. 3. The service tracks or platforms comprise one between skewbacks, another following the lower chord or soffit of the arch, and a third at the level of the railway deck. The two lower platforms carried each a single service track, and the uppermost one carried a double track and was covered tight with ⅜-in. sheet-iron plates. On these double tracks ran two 16-wheeled gantries. A transverse running trolley or four-wheeled crab was hung from each gantry and a transverse running jib crane run on the top of each. These gantries were employed to handle all the bridge material. The floor width of each gantry was 27 ft. 6 ins., and their tops stood 271 ft. 8 ins. above water level. Each had a maximum capacity of 15 tons load.

MATERIALS.—The metal used for the bridge was wrought iron, having an ultimate strength of 21½ tons (gross) per sq. in. The factor of safety allowed was nearly 6. There were 2,515 tons of wrought iron used. To this is to be added 110 tons of steel castings for skewback shoes, pedestals for piers, expansion bearings, etc., bringing the grand total up to 2,625 tons. The substructure required 217,500 cu. ft. of masonry, of which 42,000 cu. ft. were granite capping. The steel castings were secured from Germany, but all other metal was supplied by the contracting builders, the Società Nazionali di Savigliano of Turin, Italy. About 63,000 cu. ft. of timber were required for the falseworks, and this was all imported from upper Bavaria. The bridge was designed and built by the company named above, of which Mr. G. Röthlisberger is Chief Engineer, in 18 months.

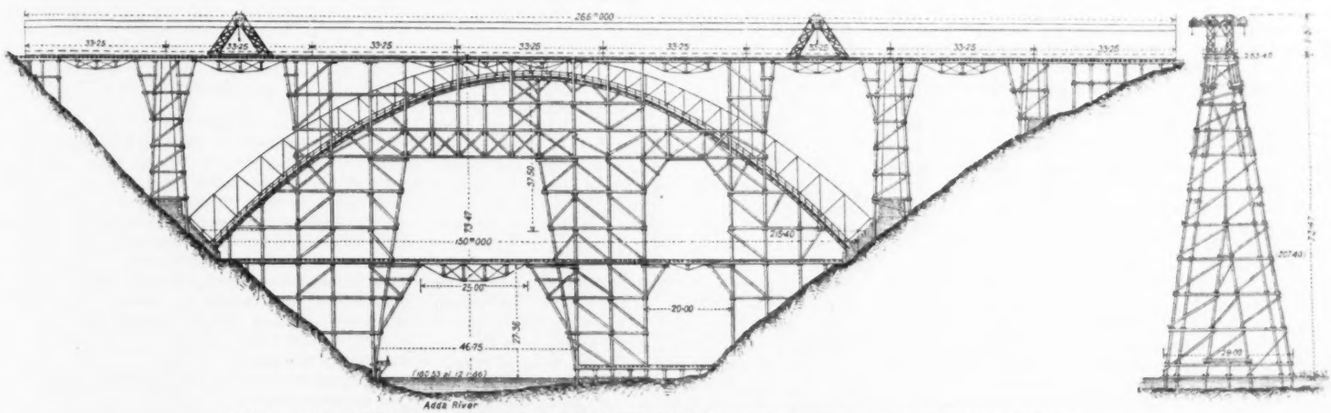


FIG. 3. FALSEWORKS AND SERVICE VIADUCTS EMPLOYED FOR ERECTING PADERNO VIADUCT.

A HYDROGRAPHIC SURVEY of the Newfoundland coast in the vicinity of the notorious Cape Race is proposed by the Canadian government. Cape Race, as many of our readers know, is one of the most dangerous points of the Atlantic coast, if not of the world, and during the last half century its rocky headlands and the treacherous currents which sweep around them have caused the wreck of scores of ships. The present survey is to be made with the purpose principally of determining the nature and courses of the dangerous currents.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

That the city of Boston is sinking at the rate of an inch or so in eight years is a proposition that cannot fail to interest engineers in that and other seacoast towns. We therefore commend to such of our readers the appendix to Mr. Freeman's Charles River Dam report, abstracted elsewhere in this issue. Not the least valuable possible result of Mr. Freeman's extended study of this subject is the attention which it naturally calls to the need of more careful standards for city levels, and better and more continuous records of related subjects, like tide gage levels, for instance. The study and the reasons prompting it also serve to illustrate the vast waste of time and energy, the generation of bad feelings, and the discredit to the engineering profession brought about through the partisan use of insufficient engineering data. Certain questions connected with the proposed Charles River Dam have been in dispute for some eight or ten years, and have contributed largely to the delay of a most desirable inter-municipal improvement. Diametrically opposing opinions have been strenuously, and in some cases bitterly, maintained, and many of these opinions, as is so often the case, have been founded on imperfect or erroneous data. The same observations would hold good of a large percentage of the so-called, and also of the real, expert testimony in judicial investigations, where, of all places, Truth should be the only aim. This state of affairs is almost universally admitted, and is quite generally deprecated by engineers, but still it continues. Occasionally a public protest is raised. Less frequently, partly because the opportunities are rare, some conscientious and able investigator, but more often out of than in court cases, manages somehow to get as nearly as possible to the bottom facts, regardless of their bearing upon any of the points at issue save the truth. Of course, we all know that, in the matter of legal testimony, no close approach to the ideal will be made until the experts, or some of them are appointed by the court, to help arrive at the Truth, instead of being chosen by the contending sides to win the suit.

The prime feature of interest in connection with the Asheville Convention of the American Society of Civil Engineers last week was its action with reference to the Union Engineering Building project. A detailed report of the discussion which took place and of its final outcome is given in this issue. We may briefly summarize here by saying that the whole matter was referred to the Board of Direction for action, with instructions that if they find the Society's interests can be safely protected in the scheme to submit the question of the Society's participation in it to a general letter ballot of the membership.

Unfortunately, an amendment was tacked onto this to the effect that this final action shall be postponed until after further discussion at the annual business meeting next January. The effect of this upon the final result may be much more important than was conceived of by those who voted for it. Will the other four organizations be content to wait the better part of the year for the American Society of Civil Engineers to make up its mind whether it wants to come in or stay out? Will Mr. Carnegie be willing to hold open for such a length of time his generous offer? Nobody at Asheville appeared to be aware of the fact that Mr. Carnegie had already paid $50,000 to purchase an option for the lots on 39th St., on which to build the Union Society House, and that this option expires on July 1.

The question arises what action the Board of Direction could take in case it should find that to delay final action on the matter till 1904 would defeat the proposition. We believe it would be fully justified, and that it would indeed be its duty to pay no attention to this resolution of the Asheville Convention, and proceed at once with the issue of a letter ballot to the entire membership. This resolution for delay was adopted at Asheville in a meeting at which we judge not more than 3% of the voting membership of the Society were present. It was adopted, moreover, with the idea that it would make no particular difference with the Society's chance to participate in the project. It was offered, indeed, by a member who made the principal speech in defense of the project for the Union House. Had it been understood that delay meant defeat, it is very doubtful indeed whether the resolution would have been carried.

Strictly speaking, it is doubtful whether the Asheville convention had any legal or moral authority to attempt to decide for the Society the important question of accepting or rejecting Mr. Carnegie's offer or to take any action that would compel its decision one way or another. Indeed, the members present manifested no wish or disposition to do this. There was general acquiescence in the idea that the details of the arrangement should be left to the Society's Board of Direction, and that the final decision should only be made by a letter ballot of the entire membership.

The main feature of interest in the Asheville convention, therefore, lay not so much in the formal resolutions adopted as in the general revelation of the temper of a representative body of the membership toward the project for coöperation.

Gaged by a verbatim report of the discussion, a sentiment adverse to the project is indicated; but this is largely because of the fact that the opponents of the project were on the spot in force, fully prepared, and that they ably presented their side of the case and took up the bulk of the time available for discussion. While there were several speakers on the other side, they assumed rather an apologetic attitude, and there was not a single bold, emphatic presentation of the merits of the scheme in a tone calculated to carry conviction. Indeed, the most important speech on the side favoring the scheme was made by a gentleman who stated at the outset that his knowledge of the scheme was confined to what he had read in the daily papers, supplemented by the statements made on the convention floor.

The question may be asked: What indications do the Asheville convention give as to the general sentiment of the membership on the proposed scheme? In answer it may be said that the opinions of the bulk of the members vary according to the manner in which the proposition is presented to them. If it is put as the opponents put it, as a proposition to consolidate or affiliate the various societies, opposition is at once raised. If placed in the true light as coöperation in the ownership and use of a building adequate to accommodate all the societies, general approval is met.

One feature which appears to arouse more opposition than any other is that the Engineers' Club is included in the scheme. Those who hold this view differ widely in their ideas and a good deal of prejudice naturally enters in; but it is nevertheless evident that this feeling must be reckoned with in forecasting the final action of the Society upon the matter. Some think that the Engineers' Club has had too large a voice in the selection of the site for the building. Others are impressed by the fact that the Engineers' Club House is to have the site on 40th St., facing the Park, while the Union Society House is to be on 39th St. They overlook the fact that the outlook on the Park is to the Club an advantage well worth paying a large additional price for, while to the other societies its chief advantage would be to the clerks employed in the Secretarys' offices. There is also, we presume, a feeling that with the attractive house of the Engineers' Club so close to the Society House, a considerable portion of the Society members would be inclined to spend their time there rather than in the Society House, and the technical and social gatherings of the Society would suffer in consequence. In reply to this it may be said that this is as likely to take place with the Society House and Club House located a mile or more apart as they now are. The man holding membership in both who prefers the Engineers' Club, will go there, and the one who prefers the Society meeting will choose that, whether the houses are located near each other or far apart.

It is apparent that one class of members are ready to use any means in their power to defeat the project, but it is equally apparent that another very large class of members strongly favor it; and will be seriously disappointed if it fails to reach success, or at least to be submitted to a fair ballot of the entire membership for decision. Both these sides are represented in the Board of Direction and it is to be hoped that that body may find a way to present the proposition in satisfactory form to the members for final decision without delaying until some time next year.

In a paper recently read before the Canadian Mining Institute, Mr. Bernard MacDonald advances a novel proposition: namely, that the Canadian Government should appropriate five or ten million dollars as a fund for prospecting the Rocky Mountains. Mr. MacDonald argues that the heavy growth of vegetation and the overcapping of debris make prospecting for minerals out of the question, if undertaken by individuals. Since the Rocky Mountains of the United States have produced nearly $3,500,000 per linear mile of the mountain system, it is urged that equal wealth will probably be found in the same mountain system to the north.

We believe that there is every probability of future discoveries of great ore deposits in the Canadian Rockies, and it cannot be denied that the almost impassable condition of that country makes extensive prospecting practically impossible at present. But when it comes to Government "grub-staking," to the tune of $10,000,000, we confess to a feeling of skepticism, to put it mildly.

The absence of roads, or even of trails, is in reality the great barrier to successful prospecting of such a timbered and mountainous country. Why is it not a far more reasonable plan to ask the Canadian Government to appropriate a few hundred thousands of dollars for wagon roads and trails? When we remember that he is a hardy man who can carry upon his own back food

enough to last three weeks, and when we know that in a mountainous and wooded region a man may not average more than a mile or two of progress in a day, we see at once the real reason why the Canadian Rockies are still terra incognita. In opening up new mining districts a government can spend money to no better advantage than in road building, and then it may safely leave to individuals the alluring lot of grub-staking the horde of hardy prospectors who will gladly "rush in where angels fear to tread."

A college thesis of an eminently practical character is printed in abstract elsewhere in this issue. It consists of the results of daily visits, with note taking, to some brick paving work going on near the University of Illinois. The preparation of such a thesis cannot fail to be of value to the student, and the results are not only a useful addition to cost data, but may stimulate many others to keep and publish records of a much-needed kind.

VOLUME OF TRAFFIC AS A FACTOR IN COMPARING TRANSPORTATION SYSTEMS.

In the discussions concerning various systems of transportation which appear from time to time, in both popular and technical literature, we continually see statements concerning the cost of transportation by different systems, and comparisons of one system with another, which are really based on fallacious grounds. For example, the good roads advocates claim that the cost of transportation over macadam roads is less than over dirt roads. The canal advocates claim that canal transport is cheaper than rail transport. The electric enthusiasts are sure that the electric motor should replace the steam locomotive, and that the old fogies who fail to adopt their views are actually losing money by their adherence to old ways and methods.

As an illustration of the sort of literature to which we refer, we quote the following from a recent official engineering document:

> On an earth road the average cost of transportation is 25 cts. per ton-mile; on the railroad it is about ¾ ct.; on water it varies from ¼ to 1-20 ct.

Such a statement, properly understood, may not be misleading; but there are indications that it is not understood, and the misunderstanding may lead to grave mistakes and losses. We desire to call particular attention to the fact that the cost of transportation by *any* system is dependent on the volume of traffic to be carried, and that no comparison of different transportation systems which fails to take this into account can be anything else than misleading.

The reason why this important factor has been omitted in much of the current discussion upon transportation systems is because another factor has also been omitted by many of those who assume to instruct the public on these matters, and that is the cost of construction and maintenance of the transportation lines themselves.

Of course, if a railway or a canal or a macadam road were built and maintained by Nature free of all cost, then there would be no need of considering the volume of traffic in comparing the relative economy of transport over them. Nature, however, has not been so kind as this. Man must build for himself his avenues of overland transportation, and the cost of building and maintaining them is as legitimate and necessary a part of the total cost of transportation as the cost of oil for a locomotive's cylinders or shoes for a canal mule.

If a fair comparison of different systems of transportation is to be made, *all* the costs of each system must be included. That looks like a plain self-evident truth. Yet it is wholly ignored in much of the current literature on transportation at the present day; and we do not speak of merely popular literature either, but of papers which lay claim to technical and scientific accuracy.

For a shining example of this we may take the above quotation, in which the average cost of transportation on railways is given as ¾-ct. per ton-mile as compared with one-fourth to one-twentieth cent for waterways. The rail rate given includes the interest and maintenance charge on the railway itself and the profits of its owners. The waterway rate includes only the rate charged by the boat with no allowance whatever for the cost of making and maintaining the waterway. It may be said that the taxpayers meet these expenses and not the shipper of goods; but this flimsy excuse does not alter the essential falsity of the comparison. If such methods of reasoning were permissible, it would be easy to prove that state-owned railways were cheaper systems of transportation than railways owned by private companies.

The above quotation is not an isolated instance by any means. It is an inveterate habit of the waterway enthusiasts in comparing the cost of rail and water transportation to wholly omit the cost of waterway construction and maintenance. A most conspicuous instance of this at the present time is the argument presented by the New York barge canal promoters. They say in the remarkable catechism which they have put forth for the instruction of voters:

> Q. Will transportation by a 1,000-ton barge canal lower the freight rates per ton per mile?
> A. Yes; the rate will be 0.52 mill per ton-mile, or 29.1 cts. per ton, Buffalo to New York.
> Q. Will the railways be able to compete with this rate on heavy freights?
> A. No; the New York State Canal Committee, after a careful inquiry of this matter, state that there is no probability of the railroads being able to carry freight at one mill per ton per mile.

Here is a direct comparison of the rail and water rates in which absolutely no account is taken of the cost of building and maintaining the waterway. Yet this is just as legitimate and actual a part of the cost of transportation as is the interest on the bonds issued to build the railway or the wages which it pays to its section men.

It is difficult to suitably characterize a "catechism" framed on such a basis. Fortunately the people for whose instruction it is issued are the ones who will have to go down into their own pockets to pay for that part of the cost of canal transportation which the compilers have ignored.

Again, in the voluminous good road literature which is being so industriously circulated one can find whole chapters concerning the great saving to be made by stone roads as compared with earth roads; but we challenge anyone to cite a solitary statement of the fact that stone roads are only justifiable from the economic standpoint where a certain minimum volume of traffic is to be accommodated. There are reams of these same "good road tracts" devoted to the lessened cost of hauling over stone roads as compared with dirt roads, but there is not a whisper of the fact that the cost of making and maintaining the improved road must be considered, if we would know the total cost of transport over it.

We hold no brief—we need hardly say—for either the railway or the dirt road. What we are arguing for is correct and sound reasoning and the application of common business principles and common sense to the solution of these problems.

We are well aware of the current answer to the objection which we have raised. The promoter to whom doubts are expressed as to the ability of his proposed transportation line to secure traffic enough to make it pay declares that the traffic will grow with the facilities; and this is true—within certain bounds and limitations; but these bounds and limitations must not be overlooked. We must not measure the growth of isolated country districts by the growth of city suburbs. There are cases of decrease as well as cases of increase. Traffic will grow with facilities, as a rule, but there is a limit to its growth, and that limit is set by the natural resources of the country from which the traffic is drawn. There are thousands of miles of railway lines in the United States which have been built in expectation of a traffic that has never been realized. A region rich in agriculture, or in mineral or timber wealth can furnish a large traffic; but when the timber is cut off or the mines are worked out, the traffic will fall off notwithstanding the facilities remain as good as ever.

The objection will also be raised, we presume, that it is difficult or impossible to estimate volume of future traffic; but this objection does not stand on secure ground. With knowledge of the natural resources of the country and of the traffic carried by neighboring transportation lines in similar districts, it is possible to reach a fair approximation of the amount of traffic likely to be obtained. Such estimates are frequently made in connection with projected lines of railway, and were carried out with great thoroughness by the commissions which reported on the Isthmian canal project and on the projected deep waterway from the Lakes to the Atlantic. Of course the growth or decline of traffic in the remote future is a doubtful matter; but this is not, after all, of great importance since the business to be handled in the early period of an enterprise is the determining factor in its success or failure. To build a railway or any other transportation route for the traffic of fifty years hence rather than for the traffic of to-day would be bad financiering, for the interest charges on the additional cost would swamp the enterprise many years before the additional traffic capacity was demanded.

LETTERS TO THE EDITOR.

The Roxbury Dam Failure.

Sir: The question in Mr. Snow's article in your issue of June 4, 1903: "Why did the dam remain in service thirty years instead of going down stream within three years from date of completion?" would appear easy to answer on the basis of well-known natural laws.

The fact that the dam, as have many others, bulged down stream before reaching a condition of equilibrium against the hydrostatic pressure proves two things: (1) That the wall, if constructed as a true monolith, would have been sufficient against overturning; (2) that it was not constructed with sufficient interior cohesion to prevent sliding.

In order to prevent failure through sliding the bulging down stream and consequent compression on the up-stream side must have caused an arching action in planes passing through the down-stream edge of the base at various inclinations. That the action of the front and percolation must have caused the decay of some essential points along the down-stream edge of the base, as well as in other parts generally, need hardly be mentioned. The bulging probably increased until the material could not stand any more the compression from that arching action at the time of the failure.

Moral: To risk money on a guess at the probable life of such a structure would seem to be a losing game.

Very respectfully, Charles R. Steiner.

618 E St., S. E., Washington, D. C., June 6, 1903.

What Is the Strength of Beams Under Eccentric Loading?

Sir: Will you kindly inform us as to whether there has ever appeared in your publication any article on the subject of eccentric loading of I-beams, or beams of any other shapes. By the term eccentric loading we mean the application of a vertical load at right angles from a bracket fastened to the web, having no other bracket and load on the other side to balance the same. A simple case would be a beam built in a wall at each end, with the web placed in its usual position, i.e., vertical, and having the load supported by a strap over the top, which strap extends down only one side of the beam. In the case of a 20-in. I-beam the eccentricity would be approximately 4 ins.

In the case of a round beam we think the correct method would be the same as is usually used for shafting, viz.: To figure the flexure due to crossbending and also that due to the twist, and use the formula given in Merriman's "Mechanics of Materials," page 134. A similar method of figuring would also apply to all regular shafts between the round and square shapes, but when an I-beam is used this procedure is undoubtedly incorrect. In fact, authorities appear to differ regarding the use of the polar moment of inertia in figuring the square shape, some claiming that this shape is much stronger in comparison to the round than the results obtained by this method would show. Any references which you could give us in this matter would be greatly appreciated by us, and if you cannot find anything which bears directly upon this subject we would be pleased if you would put the matter before engineers through the medium of your paper. As far as we have been able to find out there has been nothing in engineering literature that bears upon this method of loading I-beams. Thanking you in advance, we are Yours very truly,

Westinghouse, Church, Kerr & Co.
A. T. Nickerson, Jr.

10 Bridge St., New York City, June 4, 1903.

(We are unable to give any references on this matter, and we doubt whether any careful investigation of I-beams loaded in the manner described has ever been made. Related cases occur

rather frequently in general structural work; for instance, the triangular lattice-girder eave strut sometimes used in mill-building work, with vertical loading from jack-rafters. One way of figuring such cases is to calculate the horizontal deflecting force on each flange, and to proportion the flanges to resist the resultant of the vertical and lateral bending moments.—Ed.)

Should an Employee Bid Upon Work for an Employer?

Sir: Mr. "A," salaried civil engineer for Mr. "B," has been criticised by Mr. "C," who is agent for "B," as being "most irregular" for submitting to him ("C") a proposal to execute a specific piece of work for "B" who is not cognizant of the proposal.

The proposal is complete as to specifications, is accompanied by "A's" preliminary sketch plan (a complete one to be drafted should the work be awarded him), and offers to accept, as a compensation, 10% on the actual cost of construction, stipulating that the said 10% shall be over and above his regular salary.

"A's" proposal further explicitly states a net cost to "B" not to be exceeded. This figure, which of course includes "A's" commission as contracting engineer, is $50 less than that of an outside party, "D," who proposes to execute the work by contract, his proposal being accompanied by neither plans nor specifications.

The work if done by "A" might be very much more to "B's" financial advantage than the $50 difference between "D's" contract figure and the net figure as mentioned by "A."

Will you kindly advise me through the columns of Engineering News whether there is any professional impropriety or irregularity in "A's" proposal?

Very truly yours,

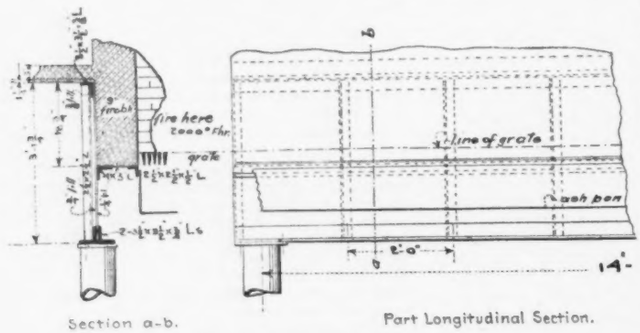
Roslyn, N. Y., June 6, 1903. F. P. Noble.

[We should say that if a salaried engineer "A," in the employ of "B," feels that he is capable of so managing a piece of contract work as to do it at a low cost for his employer "B," then he should either go directly to his employer "B" and tell him what he feels capable of doing—or hold his peace. To bid upon work for "B" while at the same time serving as "B's" employee is an act not likely to promote cordial relationship, to say the least. A salaried employee is generally expected by his employer to furnish all the skill and knowledge, for which the salary is paid, without trying to squeeze out an additional commission. Therefore, while there is nothing dishonest in "A's" proposal, in itself, there is not a little lack of wisdom.—Ed.]

Safety of a Girder Exposed to Heat.

Sir: I would be pleased to have the judgment of some of your engineering readers on the carrying capacity of the girder shown in the accompanying sketch. The conditions are, a fire of say 2,000° F. burning along upper half of the girder with only 9 ins. of No. 1 firebrick furnace lining to protect it from the heat. There is no air space between the girder and the brick and there is only a warm-air circulation on one side and on half of the other side of the girder. Would any factor of safety count in computing the condition of the girder? Yours very truly, L. Colwell, M. E.

74 Cortlandt St., New York, May 28, 1903.



A GIRDER EXPOSED TO HEAT.

(The answer to this question would depend a good deal on what was on top of the girder. Probably with one side freely exposed and 9 ins. of brick work between the fire and the girder the steel would not be heated enough to weaken it, for steel does not begin to lose its strength by heating until its temperature is over 600° F. Nevertheless if the girder supported a 12-story building or in fact any sort of structure where its failure would mean destruction of life and property we think most engineers would hesitate to assume responsibility for the design. There ought to be a way to get an air space between the girder and the fire brick, and even a small air space with a little ventilation would make a great difference in the temperature of the girder.—Ed.)

Hardwood Plugs to Hold Spikes in Soft-Wood Ties.

Sir: As my name is mentioned in the article on the above subject in your issue of April 30, I beg leave to inform you that a report respecting my paper concerning preservation of wooden ties at the meeting of the Scandinavian Railway Association will appear in the next English-French edition of the Bulletin of the International Railway Congress. In that paper I gave some information about the simple process invented by me, by which the holding power of a spike can be doubled and the durability of the tie improved. This mention is protected by United States patent No. 703,780 of July 1, 1902, and also by patents in several European countries. This invention is shown by the accompanying sketch.

The object of the invention is attained by the following means: (1) Boring a hole in the surface of the tie to a depth corresponding to that to which the prismatic part of the spike extends; (2) Filling this hole under a certain but proportionally insignificant pressure with a dowel or plug of harder wood than the material of the tie; (3) Driving a spike into this dowel. The essential advantages are a considerable improvement of the strength of the track and an improvement of the durability of the tie.

Respecting the advantages of the employment of this new and simple system I beg to submit the following summary:

The spike will adhere with about double the holding power of that which can be obtained by driving it into the wood of the tie. When using the proportionally expensive screw-spikes there is only attained a holding power about 50% greater than that reached by the use of common spikes in the ordinary way.

By the experience already gained, it has been ascertained that the tie-plugs or dowels protect the spike against every tendency of moving sideways in the tie. This, in connection with the improvement of the vertical holding power, will have the effect that probably all work of adjusting track by spikes in order to rectify irregularities in gage or in sufficient solidity in the strength of the track, owing to the loosening of the spikes, will be superfluous. In consequence, the durability of the ties will be improved, as it is impossible to apply spikes without forming new spike holes, and every new spike hole will considerably increase the risk of producing decay in the ties and thereby of their destruction.

When using tie-plugs or dowels made of creosoted beech or birch wood, it has been proved that by driving the spike into the plug the impregnating fluid can be forced into the adjacent wood of the tie, which is then protected against decay at the parts which are most liable to be affected. This is of importance, not only for untreated but also for treated ties, as in the latter the preservative from the tie-plug protects the heart of the tie.

When using hardwood plugs or dowels according to my patent, the base of the rail will partially rest on the end surfaces of the plugs, which are strongly compressed. Experience has proved that by this compression these end surfaces of the plugs or dowels get so hard, that they can stand for many years the wear of the rail base. The use of the plugs may therefore render the application of steel tie-plates superfluous, at all events for a great number of railways. For railways with heavy traffic, the tie-plug may be used in connection with tie-plates, making a very substantial track.

By using my system, softer and cheaper sorts of wood can be used for ties, as these will have equal durability with the better and more expensive ties in which spikes are driven in the ordinary way. Thus a great economy may be effected.

Finally it may be mentioned that my invention may be applied to ties already in the track and in which the hold of the spikes is slight, owing to mechanical destruction of the wood. The proceeding formerly used in such cases consisted in filling the old holes with a stick of about the same dimensions as the spike, but this gives only a very insufficient remedy of the fault. By my process of boring out all soft or decayed wood before driving in the creosoted hardwood plug, the spike is given a firm hold.

The comments which you have added to the information given by my old friend Mr. C. P. Sandberg in this matter, and which conclude your article, appear to show you are not fully acquainted with the particulars of my new process, nor with the results which can be reached by the same and which are already fully recognized in my native country and also in other European states. I shall feel much obliged if you will give place to the present explanation, which I think will be of interest to many readers of Engineering News. Yours very truly,

William Friderichs.

Technical Director of the Danish State Railways.

Helgolandsgade 12, Copenhagen, Denmark, May 29, 1903.

Notes and Queries.

J. E. B., of Providence, R. I., wishes to know whether there are any towns using a private sewerage system, installed by private capital, on a basis of rental or annual charges for connection? A list of such towns may be found in "The Municipal Year Book" for 1902.

A correspondent calls attention to the fact that the "two-peg" method" of adjustment of Y-levels is not taught in all engineering schools; and he asks: "Why do schools teach the three-peg method when the simpler two-peg method is so generally used by engineers?"

EXPERIMENTS ON CEMENT MORTAR to determine the effect of the addition of salt in cold weather and of the heating of the materials of which the mortar was composed; also, to what extent the strength of such mortar was affected by freezing, when mixed with both fresh and salt water, were conducted by the engineers of the Metropolitan Water and Sewerage Board during 1902. The mortar used in the experiments was composed of 1 part by measure of cement to 3 parts of sand. Salt was added to the mortar in the proportion of 4 lbs., 8 lbs. and 16 lbs. per barrel of cement. Briquettes were made to be broken 7 days, 28 days, 3 months, 6 months and 1 year after mixing. Only a portion of the briquettes have been broken up to the present time. The experiments indicated that the addition of salt to and the heating of the ingredients of the mortar have but little if any effect upon the strength of the mortar. The briquettes which were frozen, when broken at the end of 7 days, had less strength than the briquettes not frozen; but at the end of 28 days they had more nearly the same strength, indicating that, while the mortar is slower setting, it may not be permanently injured by freezing. There were 970 briquettes made for these experiments.

A NEW METHOD OF AUTOMATIC SOUNDING FOR MEASURING DREDGING.

Hitherto there has been only one method practically available for measuring excavation under water, the method of sounding by the lead line, the soundings being oriented either by triangulation on the sounding boat from several shore stations, or by running the boat over known ranges and spacing the soundings by time or otherwise. This method has been used most extensively by Government engineers, in making final examinations of contract dredging done in the river and harbor work. However, such sounding is very slow and expensive, and is interrupted and delayed often for days by rough or stormy weather. In Engineering News of July 3, 1902, there are described some methods of sounding dredged channels which were used on the Delaware River work for the city of Philadelphia. One of these methods was sounding from a long raft by means of a weighted wooden sounding rod, the raft being shifted transversely to its length, for successive rows of soundings, by long anchor cables. Another method was to use a short horizontal sweep which was passed over the bottom; the sweep was either held by vertical gage rods attached to a boat which was rowed over ranges, or it was manipulated by a diver working from a scow in tow of a tug.

A new method of sounding dredged waters, which is very rapid and accurate, also employs a horizontal sweep bar. It is the invention of Mr. R. M. Pardessus, of New London, Conn., and has been used recently by government engineers in examining some harbor and channel dredging done at New Haven, Conn. The sounding apparatus used gives an automatic record of the profile of the bottom along the ranges over which it is towed, and it is this unique feature that makes its work far more rapid than that of any other

sounding arrangement previously used. We show herewith a drawing of the apparatus clearly illustrating its operation; the drawing is reproduced from a print kindly furnished us by the inventor.

The entire apparatus is carried by a barge or scow, which is towed over fixed ranges at uniform speed by a tug. The sounding is performed by a transverse sweep bar fastened to the outer ends of two arms, which are pivoted one on each side of the barge and extend rearwardly down into the water. The sweep is made of a piece of railroad rail, to give the necessary weight for overcoming the buoyancy and the current effect on the arms and sweep. At the upper end of the hinged arms is a recording apparatus, which marks the profile of the bottom on a strip of paper moved by clockwork; the vertical motion of the pen is taken by levers from the pivoted sweeparm, which evidently varies in inclination with the position of the sweep. The speed of the tug and the motion of the paper being adjusted to a known ratio, the curve traced on the paper is a scale profile of the bottom along the range over which the sounding barge is towed.

For convenience in reading depths directly there are two vertical gage rods, one on each side, which are hinged to the ends of the sweep and pass vertically along the side of the barge; these rods are graduated to show the depth sounded. The gage rods are utilized also to throw overboard a marking buoy at every point where the bottom forms a ridge or hillock rising above the proper level; the manner in which this is accomplished is clearly shown in the drawing. Whenever either end of the sweep with the corresponding gage rod rises as much as a foot or more, a projecting pin on the rod lifts up a weighted marking buoy previously laid in proper position on the deck, and throws it overboard. It is a simple matter then to take a dredge to the different points marked by buoys and dredge away the hillock.

FIG. 1. VIEW OF OLD SAN JUAN RIVER BRIDGE DURING DEMOLITION, SHOWING ARCH RETAINED FOR NEW STRUCTURE.

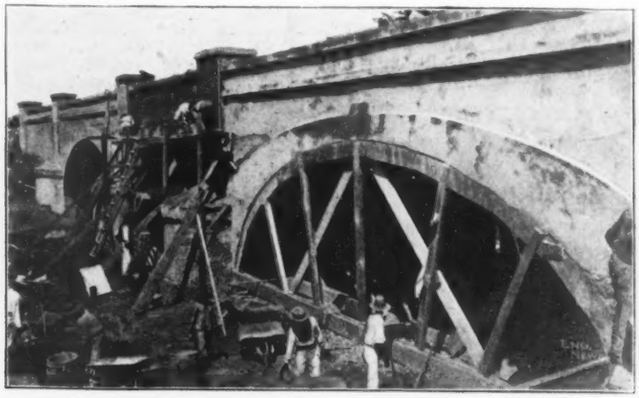
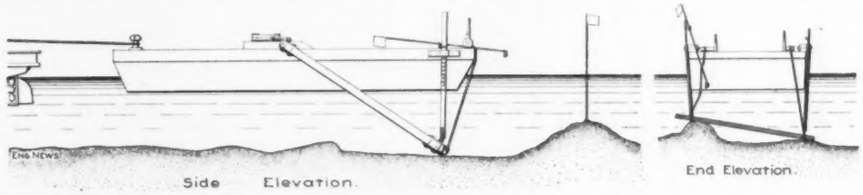


FIG. 3. VIEW OF NEW SAN JUAN RIVER BRIDGE UNDER CONSTRUCTION, SHOWING ARCH CENTERS.



AUTOMATICALLY RECORDING SOUNDING BARGE FOR SOUNDING DREDGED CHANNELS.
R. M. Pardessus, New London, Conn., Designer.

THE UNION ENGINEERING BUILDING: ACTION OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

The Council of the American Institute of Mining Engineers has taken action looking toward coöperation of the Institute with the other societies concerned in the matter of the proposed Union engineering building in New York city. At a meeting held on June 4 the Council adopted resolutions thanking Mr. Carnegie for his offer and pledging the coöperation of the Institute (subject to the approval of the members) in carrying out his wishes. The resolutions read substantially as follows:

Resolved: That the Council of this Institute extends to Mr. Carnegie a cordial and grateful recognition of his generous offer, and will do all in its power to secure the attainment of his wise and beneficent purpose and the participation of this Institute therein;

That the American Institute of Mining Engineers will unite with the other organizations above named, or any two of them, to accept the offer of Mr. Carnegie, to the full extent to which the same can now be done by this Council.

That upon the completion of the proposed building upon the site on the north side of 39th St. the offices of this Institute be removed to such building; and the Institute will accept and occupy in said building such space as may be assigned to it by a joint committee, which shall consist of an equal number of representatives from each engineering society participating in the said gift of Mr. Carnegie, and will pay, in lieu of rent, its share of such annual expense for interest on the cost of the land, maintenance, repairs, heating and lighting, etc. of said building as may be reasonably assessed upon it by the said joint committee or any equivalent managing board hereafter created, with the approval of the said representatives of the Institute, which share shall be based on the amount of space assigned to the Institute as compared with that assigned to the other organizations.

That the title to the said building shall not be held by the organizations uniting in the acceptance of Mr. Carnegie's gift as tenants in common, but shall be held by another corporation, or by trustees, in such manner that the building may continue perpetually to serve the purpose of its munificent founder.

The delegates to the Conference Committee previously appointed, are continued as representatives of the Council in all that relates to the proposed building.

In connection with this resolution, the members of the Council have over their individual signatures, issued to the Institute at large the following personal request:

We unanimously favor the coöperation of the Institute with the other organizations named in accepting the generous offer of Mr. Carnegie.

It may be necessary for the full accomplishment of that purpose, to amend the Rules of the Institute, so as to permit it to be represented jointly with other organizations in the administration of Mr. Carnegie's gift. Such amendment must be proposed in writing at the October meeting, adopted at the Annual Meeting of February, 1904, and subsequently by ballot through the mail, as prescribed in Rule VIII.

It is necessary that the practical coöperation of the Institute in the proposed plan shall be pledged without such delay. The Council has done all that it can legally do towards such a pledge; and it is understood that the personal assurance of the members of the Council as to further necessary measures will suffice for the present to make the coöperation of the Institute effective in the acceptance of Mr. Carnegie's gift. The undersigned are ready to make such a declaration if assured of the support of the membership of the Institute. The replies received to this statement will not constitute formal action on the part of the Institute, but, if substantially unanimous and favorable, will warrant the undersigned in assuming the personal responsibility of promising such future action as may be necessary.

The following information is desired from each member or associate:

(a) Do you favor the coöperation of the Institute in the acceptance of Mr. Carnegie's gift?

(b) Would you vote to amend the Rules of the Institute in such a way as to permit the incorporation of a smaller body, to hold its property, and be its legal representative? This plan is strongly favored by the undersigned.

(c) Would you vote for an amendment to the Rules, authorizing the Council to appoint a Trustee or Trustees, to hold in trust for the Institute any lease or title necessary to be thus taken or held?

It is hoped by the signers of this statement that a favorable reply to these questions will be received from a majority of the members, so that they may feel authorized to proceed in the matter of arranging the coöperation of the Institute in the Union building scheme.

CONCRETE ARCH BRIDGE OVER THE SAN JUAN RIVER ON THE ROAD FROM SANTIAGO DE CUBA TO CANEY.

By Eduardo J. Chibas, M. Am. Soc. C. E.*

Among the works planned by the American military government in Cuba and carried out or began before the inauguration of the Cuban Republic, there is probably none of so much historic interest as the new bridge over the San Juan River and the macadam road, which traverses portions of the battle fields of the Spanish-American war, and which leads from Santiago to Caney. It was at this latter place that the Spaniards made the most stubborn resistance and where the severest fighting of the war took place, on that memorable first of July, 1898, when General Lawton's Division was forcing the Spanish troops garrisoning Caney to surrender, while General Kent's and General Wheeler's Divisions were attacking San Juan Hill.

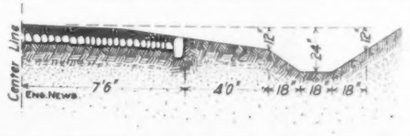


Fig. 4. Part Transverse Section of Santiago-Caney Macadam Road.

On the San Juan River crossing of the road to Caney there was an old brick masonry arch of 23 ft. span, with very steep approaches on both sides. It was over that bridge that the American troops, after taking Caney, marched to occupy the right flank of the army around San Juan Hill. From that moment it was in the midst of the scene of greatest activity of the war. A view of that old bridge is shown in Fig. 1, after the south approach had been removed and the work of de-

*Consulting Engineer and Contractor, Santiago de Cuba.

molishing the north approach had just started. The difficulty with the old bridge was that the archway did not provide sufficient room for the water to pass in time of ordinary floods and to supply that deficiency two new arches have been added: one on each side of the old arch. The new arches are of concrete, having a span of 40 ft. and a rise of 11 ft. 6 ins. The other details are

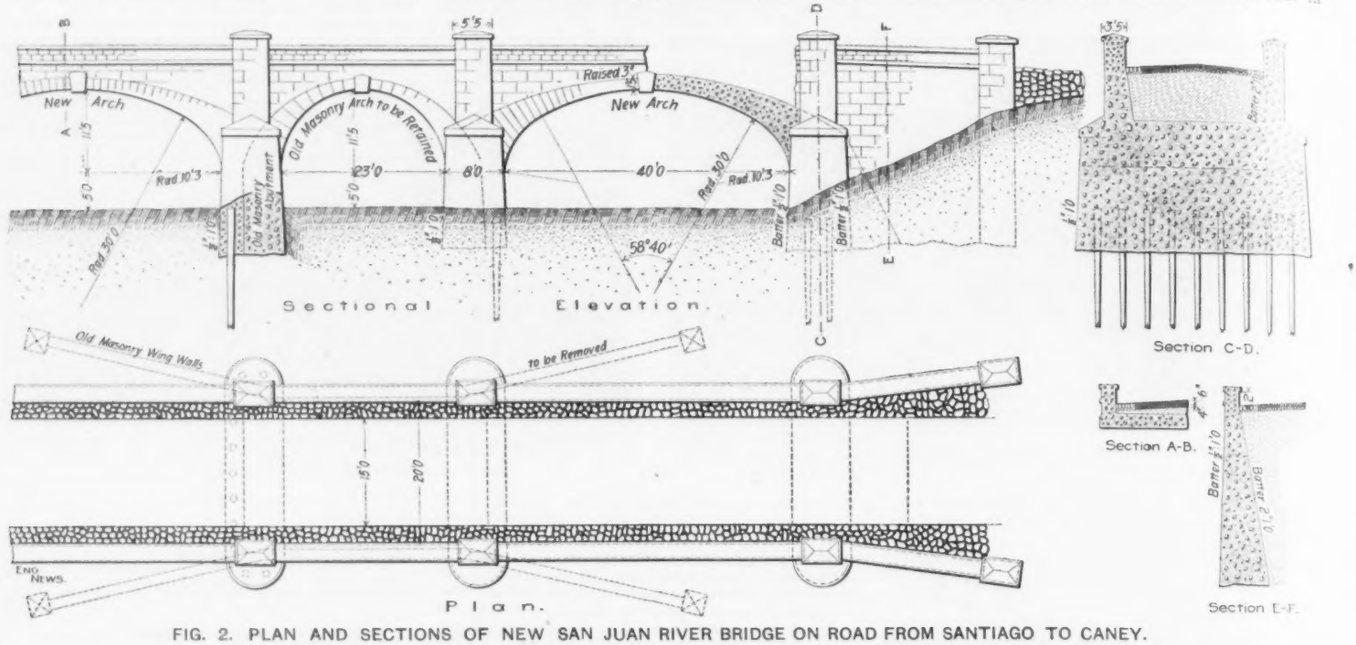


FIG. 2. PLAN AND SECTIONS OF NEW SAN JUAN RIVER BRIDGE ON ROAD FROM SANTIAGO TO CANEY.
Capt. S. D. Rockenbach, U. S. Engineer in Charge. Eduardo J. Chibas, M. Am. Soc. C. E., Santiago, Cuba, Contractor.

shown in the plan, Fig. 2, and the view, Fig. 3. The old brick arch had been built 50 years ago and as it was found in good conditions, it was left standing with some additional repairing and plastering; but the foundations were considerably reinforced. The length of the three arches from outside to outside is 131 ft., and with 25 ft. of approaches on each side, make the total length of the bridge 181 ft. The plans for this work were prepared by the Engineer's Office of the Department of Santiago under direction of Capt. S. D. Rockenbach, Assoc. M. Am. Soc. C. E., Engineer Officer, and Mr. A. S. Hobby, Jr., Assoc. M. Am. Soc. C. E., Principal Assistant Engineer.

The work was advertised and bids were received and opened during January, 1902. Out of the three bids presented, the writer's was the lowest by about $1,200, and it amounted to $31,000. The

Fig. 5. Santiago-Caney Macadam Road In Process of Construction.

approximate quantities, as well as the unit prices awarded, which represent a fair average of those prevailing in this locality, are as follows: 6,200 cu. yds. excavation at $1.10 per cu. yd.; 3,900 cu. yds. fill from barrow at 65 cts. per cu. yd.; 1,200 cu. yds. concrete at $12 per cu. yd.; 1,160 lin. ft. piling at $1.10 per lin. ft.; 3,783 sq. yds. macadam roadway at $1.05 per sq. yd.; 193 lbs. iron at 20 cts. per lb.; 1,200 sq. yds. plastering at $1.31 per sq. yd.; 119 sq. yds. paving at $2 per sq. yd., and 207 cu. yds. removal old masonry at 75 cts. per cu. yd.

Work was began towards the end of February and completed by June 1, 1902. The concrete was composed of one part Portland cement, two of clean sand and five parts stone broken to pass a 2-in. ring. The sand and cement were mixed dry; then the stone was added and the whole thoroughly mixed together with sufficient water to bring it to a plastic conditions, when it was placed in position and rammed. The government inspector at the work being an advocate of dry concrete required us to use that class of concrete at first, but after the first molds were taken off we found that the dry concrete left a very rough surface and we were then allowed to use comparatively wet concrete, as we had first desired, with very satisfactory results. The mortar, approaching a semi-liquid state, made it easier for the ramming to cause it to flow close to the planks forming the mold and when this was removed it left an even and smooth surface.

The concrete in the arches was placed in sections running along the whole width of the bridge and working from both abutments towards the crown. Shortly before stopping each day's work, a plank would be placed along a radial line, close to the concrete, and this well rammed against it so that the day's work would terminate along a radial line. About four or five days after the arch had been finished, and while the centers were still in place, two hair-breadth cracks developed on both sides of the crown and near the haunches of the arch. They were nearly in radial lines, but as they did not increase after several days' observation a very thin grout was poured over them. In most places the cracks were not sufficiently opened to allow the grout to penetrate, but where it was thought advisable they were scraped at the edges with a knife's edge or chisel. When the centers were struck about six weeks after the arch had been completed the level could not detect the slightest settlement. One of the government engineers advanced the opinion that the thin crack was probably due to a slight and unequal settlement of the centers holding up the arch. Although no distortion was noticeable in the false work we thought it advisable to guard against the possibility of it, while building the next arch, by strengthening the centers (Fig. 3) and bestowing additional care on the foundations supporting them. In addition the concrete was kept constantly wet for several days after the arch was completed and all possible precautions were taken; but a week later hair-breadth cracks developed similar to the ones observed in the first arch and they served to confirm the writer in his opinion that the main cause was unequal expansion or contraction of the large concrete mass covering a 40-ft. span without any expansion joints. The tests proved that these cracks did not in the least impair the safety of the structure nor its strength. They were so minute that in most placed they showed a mere line without any opening, and after the bridge was plastered not the slightest sign of them could be detected.

Although this bridge has proved a complete success, I would not recommend the construction of concrete arches, especially of large spans without steel or expanded metal, as the extra cost of the metal is more than compensated by the saving in the amount of concrete and in the additional strength imparted to the structure, while it does away with the possibility of cracks developing. Another concrete bridge composed of two arches of 30-ft. span each, was built near Santiago, at about the same time we were building the San Juan Bridge, and as no cracks of any kind had developed on its completion and reception by the government we thought, at the time, that a 30-ft. span was probably within the limit of spans of concrete arches that could be built without danger of cracking; but three months afterward a slight crack developed and I do not consider it due to fault of design nor to poor workmanship, but simply to unequal settling of the mass of concrete.

The abutments and parts of the wing walls and parapets were constructed of "Plum Pudding" concrete, containing 30% of large stone of from 12 to 15 ins. largest diameter and the remainder straight concrete in the proportion already mentioned. These large stones were so placed that the separation between them or from any face of the work would be at least 4 ins. The concrete arches were constructed of straight concrete. The exposed surfaces were plastered with cement mortar composed of one part cement and two of sand until a fine finish was obtained.

The paving consisted of a grouted boulder gutter from outside line of the macadamized roadway over the bridge to the parapets. Weepers 5 × 10 ins. in section were built into the wing walls at the height of the springing of the arches on the down stream side of the bridge. Mr. Oscar F. Lackey was the writer's principal assistant engineer in charge of the work.

Besides the bridge proper the cantract included the construction of about half a mile of embankments and macadam roadway nearly a quarter of a mile on each side of the bridge. Another contract comprising the

construction of the macadam roadway from the southern end of the bridge section to the entrance to Santiago was awarded to the writer at about the same time for $24,000, this being the lowest of the three bids presented. The length of the road was one a half mile and the unit prices were 65 cts per cu. yd. for excavation, 80 cts. for fill from borrow, $12 per cu. yd. of concrete for culverts, and $1.75 per sq. yd. of macadam. The stone was difficult of access as there was none on the line of the road and it had to be hauled from two to five miles over a very bad road along which it was impossible to travel on rainy days. The embankments were constructed in layers about 12 ins. in thickness, each layer being thoroughly rolled with a steam roller weighing 140 lbs. per lin. in. of bearing surface. The foundation layer of stone was composed of stones broken so as to pass a 5-in. ring and well rolled to a thickness of 6 ins. On top of this surface a layer 4 ins. in thickness of stone crushed so as to pass a 2-in. ring was spread and rolled. On this new surface an inch of good binding was spread and thoroughly sprinkled and rolled. The width of the macadam roadway is 15 ft. with 4 ft. of rolled earth embankments on each side. The section of the roadway and ditches is shown by Fig. 4, and Fig. 5 shows a section of road in process of construction.

ANNUAL CONVENTION OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION.

The eighth annual convention was held at Milwaukee, Wis., June 9, 10 and 11, the headquarters and place of meeting being at the Hotel Pfister. The meeting was called to order at 10.30 on June 9 by the President, Mr. W. A. Walker (Walker & Pratt Mfg. Co., Boston). The first address of welcome was made by the President of the Milwaukee Foundrymen's Association, Mr. W. J. Turner (Western Malleable & Grey Iron Mfg. Co.), who referred particularly to the work of the local school board in establishing a manual training school. He was followed by the Mayor, Mr. David H. Rose, who remarked that while Milwaukee is most widely known for its beer manufacture, owing to the liberal advertising of this industry, yet as a matter of fact this is not the most important manufacture. Last year the value of the iron products alone amounted to $80,000,000, to say nothing of other industries, and the beer product amounted to $20,000,000. A speech in response was made by Mr. Willis Brown (Erie, Pa.), Treasurer, who afterward presented his report, showing receipts for the year $3,176; expenses, $3,117; balance, $59.

The President's address stated that two sections had been organized during the past year, one for foundry foremen and the other for foundry metallurgists, while a section for pattern foremen is proposed. In this way it is expected to extend the usefulness of the association. As to the labor question, he hoped that the future development would be toward closer relations between employers and employees, instead of the present system where they have antagonistic organizations with large funds used in fighting each other. The President also referred to the probability of a coming decline in the wave of industrial prosperity which has been sustained for so long a time.

The Secretary's report referred to the growing development of the "continuous running" of foundries, but dealt more particularly with the need of better technical education for the apprentices and workmen, and suggested that the first step should be the preparation of short and elementary instruction papers, by a special committee; these to be given to the members for distribution among the employees. This plan is in successful use at one of the foundries of the American Locomotive Co. Original investigation for the purpose of overcoming difficulties in foundry practice was suggested, in connection with Mr. Carnegie's recent endowments for research work, and it was further suggested that many young men in the technical colleges might take up such investigations with advantage.

The question of educating apprentices, and improving the relations between men and employers came up for discussion a little later. Mr. T. D. West (Sharpsville, Pa.) thought that much of the "labor trouble" is due to the fact that employers—the men who furnish the brains and capital—do not understand the business and are therefore at the mercy of their foremen and workmen, who can take advantage of them. He and others spoke in favor of the proposed Carnegie training schools at Pittsburg, but one speaker remarked that the unions would never permit employers to set these trained young men at work. A committee was appointed to consider the preparation of elementary instruction papers, and also the matter of special investigations to overcome difficulties in foundry practice.

PROGRESS IN STANDARDIZING.

The Association has given much attention to the introducing and perfecting of standard methods, and four reports of progress in these matters were presented. The report of the Standardizing Bureau showed that the use of the Association's standards is growing in favor in this country and also abroad, and a letter was read from a Russian foundry which has been using these standards for three years.

The report of the Committee on Standard Methods of Determining the Constituents of Cast Iron stated that the almost endless modifications of well-known methods, as sent in by various chemists, have been classified, and that a study will now be made as to how far the reasons for elaborating the details of otherwise simple processes are founded on fact.

The Committee on Standard Methods of Sampling Pig Iron reported that the matter had been turned over to the Pig Iron Committee of the International Association for Testing Materials. The specifications for this work submitted last year have met with but one objection, namely: That the even distribution of the graphite is liable to be disturbed by the free use of a magnet in cleaning the sample.

The Committee on the Proper Valuation of Pig Iron for Foundry Purposes reported that the most reliable way to test pig iron is to remelt it in the cupola and pour it into regular castings. To ensure accuracy and fairness, however, everything about the test must be uniform and first class. As it has been possible to adopt a standard sand for use in testing cement, it is also possible to select a standard coke, cupola, blast furnace, etc., for testing pig iron by remelting.

A NEW CUPOLA SLAG CONVEYOR.

Mr. Thos. D. West (Sharpsville, Pa.) described a conveyor built for his foundry, where he is arranging for continuous melting of 20 to 22 tons per hour for 24 hours daily as a week's run, using hot metal from the blast furnace. It is a link-belt conveyor with a series of overlapping buckets, and is inclined. The lower end receives the slag from the slag spout, and the upper end delivers it onto the dump or into cars. In order to avoid rehandling the slag to recover the iron, it is proposed to effect this recovery before dropping the slag into the car. The amount of slag will be about 50 lbs. per ton of iron melted, and may contain 4% of shot iron, an oxide of iron equivalent to 15 or 20% of the metal, and also such iron as may overflow with the slag. The conveyor was built by the Bartlett & Snow Co., of Cleveland, O.

At the afternoon session, Mr. J. Leon Gobeille, President of the Gobeille Pattern Co. (Cleveland, O.) gave a practical talk on "The Organization, Maintenance and Management of a Modern Pattern Shop." This proved to be of particular interest, and it was illustrated by plans and photographs of shops and shop devices designed by Mr. Gobeille. He disapproved of heating by the blower system on the ground that it blows dirt and dust into the room. The pattern maker should be better instructed as to methods of casting, so that he can work to the best advantage, and Mr. Spence (Chicago) said that in one particular shop young men are given two years in the foundry before going to the pattern shop. As a rule, very little consideration is given to the matter of making patterns in such a way as to reduce the cost of molding. Mr. Gobeille considered that the best pattern foreman may be one who never made a pattern, but is able to handle his men. Graduates from technical schools, who are almost ignorant of the business, often make good men of this kind, as their training has fitted them to see into and ahead of their work, and to devise new methods and improvements. He has employed many such young men, paying them $1,000 a year, and has always found they give him valuable service before they leave for better positions.

The session then organized into the foundry foreman's section, and the chair was taken by Mr. A. M. Loudon (New York), Past-President of the Foundry Foreman's Association.

A paper describing "A Simple Device for Ascertaining the Average Silicon in an Iron Mixture" was read by Mr. A. W. Walker, and this we shall publish later. A brief paper on "Foundry Management," by Mr. David Spence (Chicago) outlined the requirements of a foreman and a manager, and pointed out the necessity of checking small wastes. Mr. James A. Murphy (Erie, Pa.) followed with a paper on "Permanent Molds," describing brick molds in pits for large kettles or pans. One member spoke of using iron molds and cores and no pits for this same class of work.

MOLDING MACHINES.

Two interesting papers on this subject were read by Mr. E. B. Gilmour (Peoria, Ill.) and Mr. S. H. Stupakoff (Pittsburg, Pa.). The discussion was brisk and showed a thorough unanimity of opinion as to the practical successs of such machines, and the absolute necessity of having them operated by laborers and not by molders if successful results are to be obtained. Molders oppose the introduction of the machines, and where they do work them the output is limited and they are always having trouble with machines out of order. When laborers are put at the same work on the same machines, they will increase the output sometimes 300%, with less cost of operating and a lower percentage of lost or faulty castings. In one case, where 60 flasks of small sheaves were made daily by hand by molders, 150 flasks per day were made by machines worked by laborers, and the castings were of better quality.

The last paper of the session was one on "The Trials of the Foundry Foreman," by Mr. A. M. Loudon (New York), showing the foreman's side of the difficulties of foundry management.

RETORT OVEN COKE.

At the evening session, the first paper read was on "Retort-Oven Coke for Foundry Use," by Mr. W. T. Keep, of Detroit. In the absence of the author it was read by Mr. W. S. Blauvelt (Solvay Process Co., Detroit). This described the process of manufacture in beehive ovens and in retort ovens, and showed that although the appearance of the latter coke is an objection among foundrymen accustomed to the ordinary coke, yet it is highly satisfactory and makes very hot iron. Mr. Keep now used retort-oven coke exclusively in his foundry. Samples of coke made in the retort-oven plant at Detroit were exhibited, and in the discussion it was stated that two types of retort ovens are now in use in this country: the Otto-Hoffman and the Semet-Solvay.

MALLEABLE CAST IRON.

A paper on malleable iron was then presented in abstract by its author, Dr. Richard Moldenke (New York). In the discussion which followed, Dr. Moldenke remarked that he doubted if malleable iron could ever be used for highly-finished castings, such as those required in stove works, etc., where sharp edges and clear surfaces are obtained by the use of iron high in phosphorus. With malleable castings, the edges are always rounded, and the finished appearance is always more or less rough.

A short paper on "Employer and Employee" was then read by Mr. S. H. Stupakoff (Pittsburg), who presented the employer's side of the labor question, showing the commercial and financial obligations and difficulties of the manufacturer, which conditions are not realized or allowed for by the employees or their unions. The injustice of imposing upon the employer arbitrary conditions as to the employment, discharge and pay of his men, without any such conditions as to the quantity or quality of the men's work, was also touched upon. Two papers, illustrated by lantern slides, concluded the evening session. The first was on "The Heating and Ventilating of Foundries and Machine Shops," by Mr. W. H. Carrier, of the Buffalo Forge Co.; and the second was on "The Principal Factors of the Iron Industry in the

Birmingham (Ala.) District," by Mr. S. S. Knight, Manager of the Birmingham Pipe & Casting Co.

At the morning session on June 10, there was first a small gathering of members particularly interested in the chemical side of foundry work. During a general discussion on the methods for determining the constituents of cast iron, as compiled by Mr. H. E. Field, Secretary of the Metallurgical Section, it was pointed out that managers are not interested so much in methods as in results. That is to say, when a manager wants a certain quality of iron from his cupola, he does not care very much what methods are employed in determining how this quality is to be produced as long as it is actually produced. There is a great variation in the methods of analysis employed by different chemists, each introducing his own modifications, and it is not well to strain too far in the attempt to standardize chemical methods.

After a recess, the general meeting assembled, and was devoted to the proceedings of the Metallurgical Section. Mr. W. W. Davis (Roanoke, Va.) read a paper on "Blast Furnace Conditi ns Affecting the Chemical Condition of Foundry Iron," of which we shall give an abstract.

BUYING PIG IRON ON SPECIFICATION.

This was an important paper by Mr. H. E. Field (Ansonia, Conn.), discussing the commercial relations between blast furnaces and foundries. Under present conditions, foundries which have placed contracts for certain grades of iron when prices are low often find great difficulty in getting these grades delivered if prices rise, the furnaces preferring to sell their product to other purchasers at the higher prices. To check this practice, it was suggested that the specifications should include clauses providing for a certain reduction in price proportionate to the variation in percentages of silicon, sulphur and phosphorus of the iron delivered, from the percentages required by the specifications. In a brief discussion Mr. G. W. Scott (J. I. Case Co., Racine, Wis.), whose specifications for pig iron and foundry materials were published in Engineering News some months ago, stated that he had used such clauses with success. After certain furnaces had suffered once or twice from the enforcement of the penalties there was no further trouble in getting the grade of iron specified.

After a few remarks on the recovery of nickel from the scrap anodes used in the nickel-plating process, and a brief congratulatory address from Prof. Koznian, of the University of St. Petersburg (Russia), the meeting adjourned.

A short meeting on June 11 was given up to the business affairs of the Association. It was proposed that steps be taken to interest local associations of foundrymen, and to induce their members to become members of the national association. Mr. Willis Brown also suggested that the "Journal" of the Association should in future be published at regular intervals. It was voted to appoint a committee to consider these matters.

On motion of Dr. Moldenke, who referred to the fact that the Association is well known abroad, the following two gentlemen were elected Honorary Members: Prof. Thomas Turner, University of Birmingham (England); and Prof. R. Ledebur, University of Freiburg (Germany).

For the place of next meeting, St. Louis and Indianapolis were proposed, and it was suggested that the business part of the meeting be held at Indianapolis, to be followed by a trip to St. Louis. It seemed to be a general opinion that St. Louis should not be selected, as even if the necessary accommodation could be secured (which is doubtful) the Exhibition would attract the members and the technical proceedings of the convention would suffer. The matter was eventually left to the incoming administration.

The number of papers was far beyond what it would have been possible to present at the four business sessions, even though many of them were quite brief. A somewhat discouraging feature of the convention was the absence of free discussion of the papers read. The only papers which gave rise to a real discussion were those on "Pattern Shops" and on "Molding Machines," others being passed with brief remarks by one or two speakers, or with no remarks at all. The following papers were read by title:

"The Continuous Operation of the Iron Foundry," J. C. Knōeppel; "Foundry Responsibility," F. W. Stickle; "Foundry Control," R. P. Cunningham; "Note on Continuous Molding," Edward Richelieu: "Technical Education in the Foundry Office," I. G. Stuart; "Note on Methods of Estimating," Wm. Hanson; "The Metallurgical Engineer in the Foundry," Henry Souther; "Loss of Sulphur in Borings of Cast Iron," W. E. Dickson; "Notes on the Micro-Structure of Cast Iron," Percy Longmuir.

ENTERTAINMENTS.

The principal excursion was to the Soldiers' Home and the West Allis shops of the Allis-Chalmers Co., on the afternoon of June 10. A stop of 45 minutes was made at the Home, and an hour was allowed at West Allis, the trip through the shops ending at the pattern-storage house, where a lunch was served. Several of the large foundries in the city were visited, and one party also visited the Northwestern Foundry, where links for chain belting are made. Some of these are small enough for light dog chains, and were regarded with interest by certain visitors in charge of foundries making no castings smaller than 10 tons in weight. Drives and trolley rides were provided for the ladies, and the entertainments included a reception and a smoker, with a concert on both occasions.

OFFICERS.

The following officers were elected for the ensuing year: President, Willis Brown, Erie, Pa ; Secretary and Treasurer, Dr. Richard Moldenke, New York, N. Y.; Assistant Secretary, H. E. Field, Ansonia, Conn.—Metallurgical Section: Chairman, W. G. Scott, Racine, Wis.; Secretary, H. E. Field, Ansonia, Conn.—Foundry Foreman's Section; Chairman, Charles H. Thomas, Newark, N. J.; Secretary, J. A. Murphy, Erie, Pa.

THE SPIER FALLS DAM OF THE HUDSON RIVER WATER-POWER COMPANY.

Engineering construction works of such great magnitude are in progress throughout the United States that it is quite possible for a work involving millions of dollars to be almost completed before a description of it is made public. The Spier Falls dam, one of the great dams of the world, is a case in point. Work was begun upon it three years ago (June, 1900) and the masonry work will be practically completed before the first of August. Since this work has involved the excavation of some 270,000 cu. yds. of rock and earth, the building of 180,000 cu. yds. of masonry, beside the construction of enormous cofferdams, it is quite evident that a new record for rapid dam construction has been established. The force of men upon the work has at times exceeded 1,500 men, working day and night, and since the laying of masonry was commenced 8,000 cu. yds. of concrete and stone masonry have been placed each month.

LOCATION OF THE DAM.—The location of the Spier Falls Dam, as shown in Fig. 1, is at a point in the Hudson River about nine miles southwest of Glens Falls, where the building of the dam will create a reservoir five miles long, one-third of a mile wide, giving an 80-ft. head of water. Ten turbines, each capable of developing 5,000 HP., will drive dynamos feeding electricity to Saratoga, Schenectady, Glens Falls, Troy and Albany. Even at times of low water the minimum power development will be 20,000 HP. The location of the dam and the plant used in its construction are shown in Fig. 2.

COFFERDAMS.—One of the most interesting of the features of this great work is the cofferdamming. Since the bed of the river at Spier Falls was a mass of boulders, underlaid in many places by cemented gravel or hardpan, cofferdams of log cribwork loaded with rock were necessarily adopted. Figs. 3, 4, 5 and 6 show different views of these crib cofferdams, Fig. 5 showing the main upstream cofferdam extending to the right bank of the river. The cribwork in this main dam is now almost entirely covered by the material excavated from the dam site, which served to reinforce it. After the cribwork was in place a heavy fill of broken rock was made along its upper face, and regarding this rock-fill, Chief Engineer Charles E. Parsons says it was

the most essential feature of the work, for it would have been almost impossible to have stopped some of the larger leaks without it. When a leak started, these stones would settle and lodge, and it was then an easy matter to hold the outer gravel fill.

In making this rock-fill, the largest stones were placed against the cribwork, and then covered with rubbish from the quarries. The gravel for the final layer was excavated with a steam shovel and delivered by cars hauled by "dinkeys," so that after two months' work with the steam shovel the main part of the cofferdam was practically tight. This main cofferdam (Fig. 5) at its greatest cross-section is 250 ft. wide at its base, 80 ft. at its top, and is 90 ft. high. It is about 600 ft. long, and its average dimensions are about 150 ft. wide at base, 25 ft. wide at top, and 60 ft. high. After the completion of this main cofferdam a 6-in centrifugal pump handled the entire

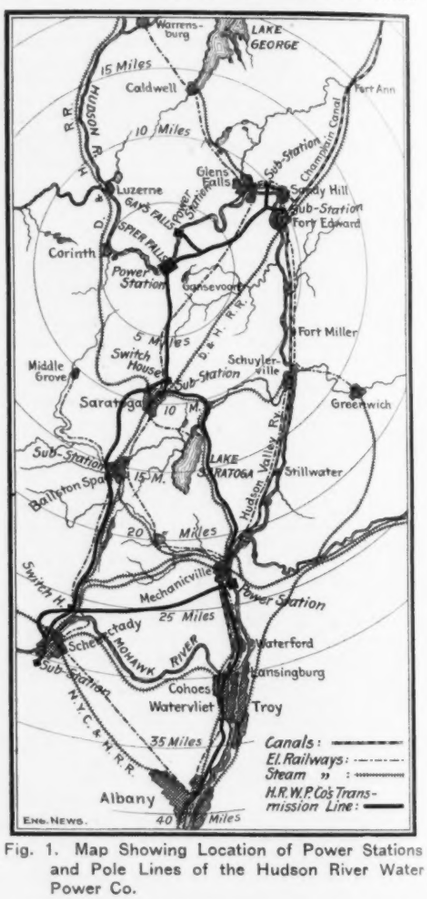


Fig. 1. Map Showing Location of Power Stations and Pole Lines of the Hudson River Water Power Co.

leakage, which indicates what a substantial structure it is.

Referring to Fig. 2 we see the river now flowing along its left or north bank, to which it was diverted by the cofferdam just described. Originally it flowed straight through the site of the cofferdam, and where the river channel now is, along the north bank, there was a bed of gravel and boulders 35 ft. deep. The spillway masonry was built first, on the north side of the river, four archways, 7 × 10 ft., being left to carry the river. These archways are 35 ft. above the old river bed, and will eventually be closed with sliding timber gates, and permanently filled in with masonry. In constructing the main cofferdam, a gap was left about 100 ft. wide, as shown in Fig. 3, the gap being bridges so that stone and gravel could be hauled across. The spring freshets in 1901 undermined the north side of this gap, and dug deep into the old river channel, making closing of the gap more difficult. To effect this closing, a heavy timber crib was begun on the north side of the opening, Fig. 6, and was sunk to the bottom by using green hardwood timber, wire cables being used to anchor it during con-

struction. It was then partly filled with stone and built up 6 ft. above the water. In like manner a crib was built out from the south side of the gap, until a small wedge-shaped gap was left 20 ft. wide at the upstream face, and 6 ft. wide at the dowstream face. A crib was then made to close this gap, and was suspended by hemp ropes until it was built up to a height of 30 ft. above the water, when the ropes were cut and the wedge dropped into place. After these gap or foundation cribs were in place, they were filled with stone until the water rose nearly to the top. A sluiceway 20 ft. wide was then built to carry the river over the foundation cribs, and more stone was thrown into the cribs to raise the water until it flowed through the sluiceway. Another sluiceway was then built, six feet higher than the first, and the water diverted to it by building up the crib and finally closing the front of the first sluiceway with 6-in. plank. In this manner the water was raised step by step, 35 ft. until it found an outlet through the temporary archways in the spillway. The method of thoroughly stopping of leakage by rock and gravel filling above the cribwork has already been described.

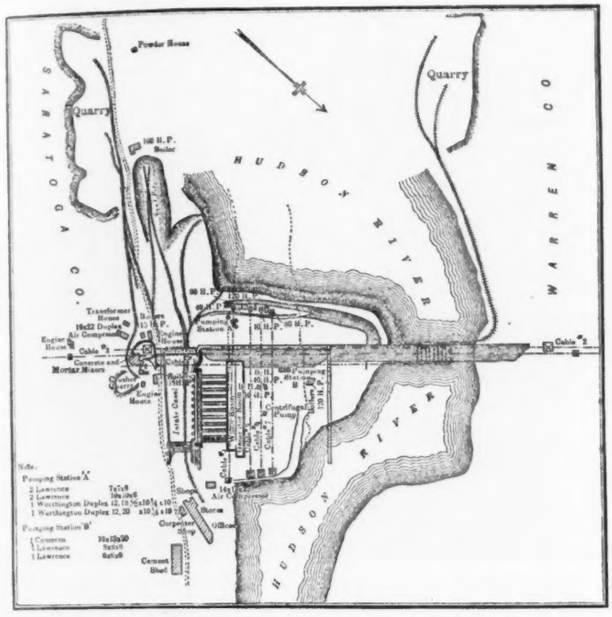


FIG. 2. PLAN OF SPIER FALLS DAM AND CONSTRUCTION PLANT.

As is inevitable on work of this character and magnitude, delays and damage from floods occurred, but each new problem was met and solved in a manner most creditable to the skill and pluck of the engineer in charge—Mr. Charles E. Parsons.

BAILING AND DRAINING.—The pumping plant consisted of five 8-in. and three 6-in. Lawrence centrifugal pumps, two 4-in. pressure-pumps, and two compound 8-in. Worthington pumps, and at times this plant was strained to its limit to lower the water enough to locate the larger leaks. After the leaks were stopped four pumps served. The water leaking through the upper or main cofferdam is raised 80 ft. in two lifts by 8-in. centrifugals. The total leakage from all the cofferdams is about four million gallons (534,140 cu. ft.) each 24 hours.

THE DAM CROSS-SECTION.—Figs. 7 and 8 show cross-sections of the dam proper, and it will be seen that the River Section (where the river used to flow) extends to a depth of 60 ft. below the old river bed. The Overfall Section is shown also in Fig. 9, and the River Section in Fig. 10. Since the rock upon which the dam is founded is very hard and granitic, and since the masonry itself is massive, there is evidently not the slightest chance of failure from any cause.

MASONRY.—Fig. 9, just referred to, shows very clearly the size of the rough granitic blocks forming the core of the dam. The rock is quarried a short distance above the dam and delivered to the transverse cableways by rail, as shown in Fig. 2. The powder used is 60% dynamite. The most regular stones are selected for the faces of the River Section of the dam, but even on them there is very little work expended in dressing, while the backing is not dressed at all. The mortar in the backing is a 1-3-5 concrete, the cements used being Ironclad and Atlas. This use of concrete instead of ordinary mortar between the stones obviously effects a decided saving in the cement item without impairing the solidity of the masonry; and to further reduce the cement per yard of masonry, large spalls are also used in filling the vertical joints between the huge blocks of stone. This class of masonry may be called rubble-concrete; it really is a rubble with concrete for mortar. The percentage of concrete so used has not yet been calculated, but it will probably be about 30% of the whole dam. The labor cost of laying this masonry, not including the cost of mixing the concrete, has been about 60 cts. per cu. yd. There are two laborers employed to every mason, their wages being respectively 15 and 35 cts. an hour. It will be noted that the use of concrete not only effects a saving in the labor item, but it effects a saving in the labor item by reducing the number of high-priced masons.

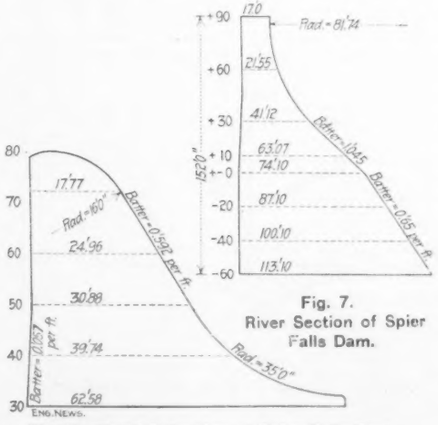


Fig. 7. River Section of Spier Falls Dam.

Fig. 8. Overfall Section of Spier Falls Dam.

For dam work this type of masonry has evidently the great merit of comparative cheapness, while at the same time, in our opinion, it is fully as effective as any other type of masonry that might be used. Where stone is tough and comes out in such masses as this does, it would be simply folly to reduce it all to concrete size. In these days of concrete it is the part of wisdom not to ignore the fact that rubble masonry in massive structures, and particularly rubble with concrete as mortar, will usually be found cheapest.

The face stones in the River Section, on the downstream face, are laid with their beds inclined to the horizon, as shown in Fig. 10. And in the laying of this work the engineer has again shown his good judgment by laying the stones dry, and grouting the joints. The grout is mixed in small quantities nearby and is poured in quite thick, a steel rod being used to force it down to the bottom of the joints, and insure against a clogging that might prevent the full bedding of the stone in mortar. After viewing the work there is not the slightest doubt that this grouting secures a much better joint than laying in dry mortar. We are aware that many authorities condemn grouting on two grounds: (1) because grouted mortar has less tensile strength, (2) because it may clog in the joint and not fill below. The first of these objections is of very little weight, for grouted mortar has only slightly less tensile strength, perhaps 15% less than dry mortar; and it has enough strength for any masonry. The second objection is of far greater weight, but it applies most forcibly to very narrow joints. Where joints are 1 or 2 ins. wide, and a metal rod is used to insure free running, there is no danger of not securing a well-filled joint.

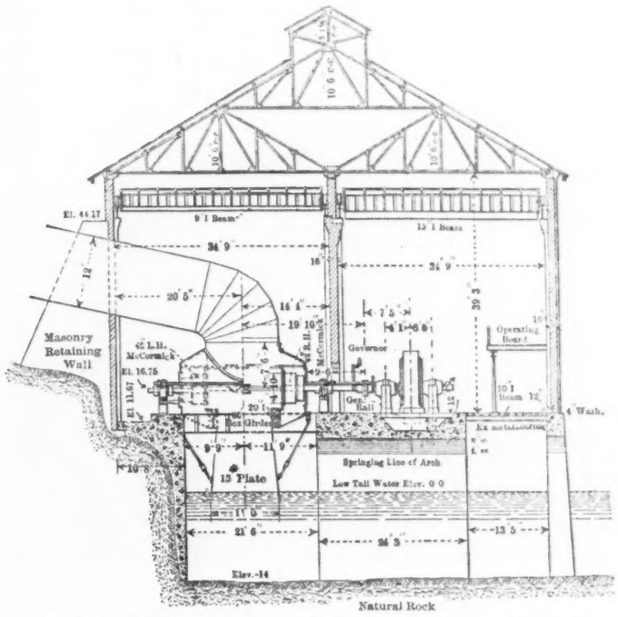


FIG. 13. POWER HOUSE, HUDSON RIVER WATER POWER CO.

The face stone on the overflow section were imported several miles by rail and boat, for it was found very expensive to dress the local stone to the ½-in. joints used on this part of the masonry. As a matter of fact, it cost $24 a cu. yd. to quarry, dress, deliver and lay the local stone in the face, as against $15 for the imported stone.

DERRICKS AND CABLEWAYS.—Seven Lidgerwood cables are in use; three parallel with, and four perpendicular to the dam, as shown in Figs. 4 and 5. Two of these are the longest cableways ever used, one being 2,140 ft. between towers and the other being 1,660 ft. The main cable on the first named is 2½ ins. diam., and the cables of the others are 2 to 2¼ ins. The four transverse cableways are each 700 ft. long.

For handling the stone after it has been delivered by the cableways, stiff-leg derricks are used. As the dam increases in height, these derricks are raised to successively higher platforms anchored to the sloping face of the dam, as shown in Fig. 11. The rear stiff-legs have been lengthened by splicing until now there is one derrick with a rear leg 113 ft. long. Guy-derricks could not be used because the guy lines would interfere with handling the cableway skips.

CONCRETE.—The crushing and mixing plant is located, as shown in Fig. 2, so that by means of a circular car track the mixed concrete is delivered in buckets on cars to the long cableways. Three Ransom mixers, each of 1 cu. yd. capacity, are giving excellent service. Two of the mixers are running on concrete, and the third on mortar. Each concrete mixer turns out about 200 batches every 10 hours, there being 23 cu. ft. of concrete to the batch. The concrete is discharged into an iron bucket holding 2 cu. yds. The bucket is hauled away on a car by a mule, and delivered to the cableway. All the materials are fed by gravity into the mixer. The sand is delivered from the pit in dump cars, and is raised by a bucket elevator. A rotary screen takes the pebbles out, and to prevent clogging of the screen it has been found very advantageous to fasten long baffle plates to the inner side of the rotary screen. These plates carry the sand around and drop it when a certain inclination is reached. The sand is discharged from the screen into a bin, and fed by means of a chute controlled by gates. The cement is raised in bags by means of a belt conveyer.

The stone from the quarry is fed into a No. 6 Gates crusher having a capacity of 50 tons per hour; and is elevated and screened. All pieces larger than 3 ins. diam. are returned in a chute to a No. 2 Climax jaw crusher. The pebbles from the sand are also delivered by a chute to the jaw crusher. The crushed stone and water are first admitted to the mixer, then the sand and cement, and in less than two minutes a perfect mixture is secured. There are about 30 men engaged in and about the mixing plant, including men feeding the crusher, feeding the materials from bins into the mixers, attending to mixing and dumping, loading cement on to belt elevator, men opening cement bags, driving mules and switching cars, and others performing sundry duties.

A large part of the concrete is now being used in building the walls and floors of the power-house. In the foundation walls the concrete is deposited very wet, and a layer of stone, or large spalls, is bedded into each layer of concrete, the men jumping on each stone to push it down into the soft concrete. Spades are used to force all stone back from the face of the wall, so that there will be 2 or 3 ins. of pure mortar on the face.

HAULING BY WAGONS.—Over sandy earth roads from Glens Falls all the cement, coal and machinery has been hauled in wagons, a distance of nine miles. One round trip a day is made, teamsters being paid by the ton of load hauled. The loads hauled by each team have ranged from 3,500 to 4,500 lbs., and this despite the steep pull at the end. Teams travel in pairs so that one can act as a snap-team for the other in making the ascent at the end of the trip. To have hauled more than two tons as a net load on such a road is certainly a remarkably good performance and speaks well for the horses and the care given them by the teamsters.

Fig. 12 shows a piece of machinery weighing 14 tons, supported between two wagons. The interesting feature of this photograph is the steering device, by means of which one man controls the front wheels of the rear wagon. It will be seen that a rope fastened to the stub tongue passes through snatch blocks to the drum controlled by the steering wheel.

One load of 28 tons was drawn on rollers running on timbers, much as in house moving, and 12 teams were required to move it, taking nine days to travel the nine miles.

POWER HOUSE.—The power house, Fig. 13, will be divided into three sections: (1) the wheel room, (2) the generator room, and (3) the transformer and switchboard room. In the wheel room there will be ten pairs of turbines, each having a capacity of 5,000 HP. under an 80-ft. head. The wheels are set 12 ft. above the level of the tail race water, and each pair has one draft tube. The generator room will contain ten 3,350 HP., three-phase, 2,000-volt, 40-cycle, direct-connected General Electric generators, running at 240 rev. per min. There will also be three 265 HP. exciters, each direct connected to its own water wheel. In the transformer room there will be 30 1,100 HP., high-potential transformers, beside motors and blowers, and the high and low-potential switchboards.

POLE LINE.—Fig. 14 shows one of the standard poles and cross-arms with a special angle-iron brace that has given excellent satisfaction. The location of the pole lines is shown in Fig. 1.

FIG. 9. MASONRY OF OVERFALL SECTION, SPIER FALLS DAM.

FIG. 12. STEERING GEAR USED IN HAULING 14-TON LOAD TO SPIER FALLS DAM.

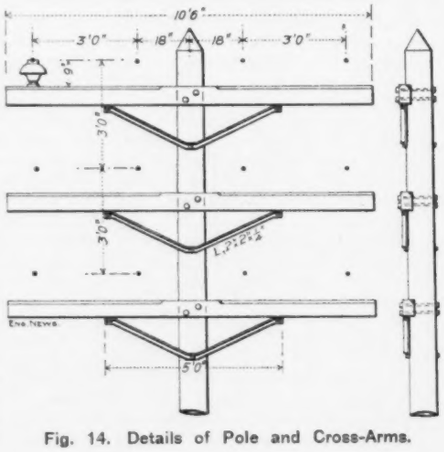


Fig. 14. Details of Pole and Cross-Arms.

The five feeder circuits have a capacity of 50,000 HP., and the longest circuit will be 42 miles.

ENGINEERS AND OFFICERS.—The Hudson River Water Power Co. owns all the plant with which the dam is being built, and its Chief Engineer, Mr. Charles F. Parsons, has charge of the construction work. We have already spoken of the able way in which the work has been handled in the face of many difficulties. The officers of the company as at present organized are: President, Mr. Eugene L. Ashley; Vice-President, Mr. Walter H. Trumbull; Secretary, Mr. Elmer J. West; Treasurer, Mr. E. H. Gay; Auditor, Mr. C. H. Peddrick, Jr. To the indefatigable energy of its President, Mr. Ashley, is due the credit of having secured the capital for this great undertaking.

FINANCIAL RESOURCES.—Some idea of the financial resources of the company may be had from the following statement:

Contracts.

General Electric Co., 10,000 HP.	$246,875
Glens Falls Portland Cement Co.	22,500
United Traction Co., Albany, 6,000 HP.	162,500
Glens Falls Portland Cement Co., 1,000 HP.	22,500
Municipal Gas, Co., Albany, 6,000 HP.	366,800
Troy Lighting Co., 6,000 HP.	370,200
Watervliet Power Contracts	25,000
Other earnings	47,473
Total	$1,241,348

Beside these contracts 6,297 HP. has been applied for in other villages and cities. The Hudson River Water Power Co. has outstanding $2,000,000 of 5% bonds, and the Hudson River Electric Co., to which it delivers the power at the dam, has a like amount of bonds, making annual interest charges of $200,000. To this must be added $100,000 for estimated operating expenses and $56,000 interest on bonds of companies absorbed. The prospective annual net earnings are, therefore, estimated to be nearly $900,000.

ACKNOWLEDGMENTS.—Figs. 2 and 13 are reproduced from a paper read by Mr. Charles F. Parsons before the American Institute of Mining Engineers at the recent Albany meeting. We are indebted to that paper for some of the facts above given, and to the officers of the Hudson River Power Co. for courtesies extended to our representative, and for facilities afforded in examining their dam at Spier Falls.

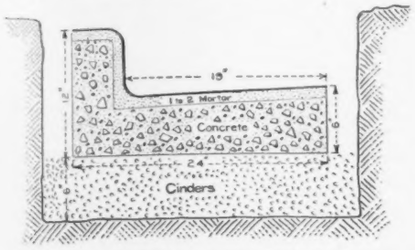
COST OF BRICK PAVEMENTS IN CHAMPAIGN, ILL.*

By Charles Apple.†

It is the object of this paper to give some costs on the details of the work of constructing brick pavements in Champaign. The writer had no official connection with the work, but visited it daily and kept a record of the progress. Attention was given to the amount of material used, the number of men employed, and the occupation of each. The results thus obtained were checked by comparison with notes kept by the special inspector and also with information furnished by the contractor's superintendent.

Practically all the pavements were for streets in the residence district, and were built with a combination concrete curb and gutter, a 6-in. concrete foundation, and a clay paving block wearing surface.

The contract for the work was let in three parts as follows: (a) Concrete curb and gutter complete, at 45 cts., and 46 cts. a lin. ft.; (b) Grading of the street between gutters, at 23 cts. per cu. yd.; and (c) the concrete base, sand cushion, brick wearing surface and sand filler, with all necessary rolling, $1.29 per sq. yd.



Concrete Curb and Gutter for Brick Pavement at Champaign, Ill.

CONCRETE CURB AND GUTTER.—The concrete curb and gutter, the first portion of the work constructed, was built in a trench as shown in the cut. The earth was removed from this trench with pick and shovel at a rate of 1 cu. yd. per man per hour.

The concrete work was built in alternate sections, 7 ft. in length. A continuous line of planks was set on edge to form the front and back of the concrete curb and gutter; and wood partitions staked into place, were used. The cost of the work is shown in Table I.

GRADING.—The grading was done with drag-scoop scrapers, wheel-scrapers and wagons, each being used as demanded by the length of haul. Earth was loosened with plows to within 3 ins. of subgrade and this last layer then removed with pick and shovel.

The cost of removing the last 3 ins. was 2 cts. per sq. yd. with labor at $1.75 per day of 10 hours. For a total of 26,715 cu. yds. of grading the city paid 23 cts. per cu. yd., or $3,844; and since there were 38,504 sq. yds. of pavement the cost of grading was 9.98 cts. a sq. yd. of paved surface, or say 10 cts., which price will be used later in this article.

The subgrade was compacted with a horse-roller weighing 150 lbs. per lin. in. at an average cost of about 0.05 cts. per sq. yd.

THE PAVEMENT.—The concrete foundation was composed of 1 part by bulk of natural cement, 3 parts of sand and gravel, and 3 parts of broken stone. All the materials were mixed with shovels, and were thrown into place from the plate upon which the mixing was done. The material was brought to the steel mixing plate in wheelbarrows from piles where it had been placed in the middle of the street, the length of haul being usually from 30 to 60 ft. The cost of the work was as shown in Table II.

When the concrete base had set, a sand cushion 1¼ ins. thick was placed upon it, and upon this the brick wearing surface was laid.

The cost of the brick wearing surface is given in Table III., and is based upon the assumption that 1,000 paving blocks will lay 25 sq. yds. of pavement. This ratio was determined by actual count after the pavement was laid. To this cost will have to be added something for rejected bricks, the amount depending upon how closely the grading is done at the kilns.

The cost of handling, laying etc., was originally determined as so much per 1,000, but is converted into the square yard basis for convenience in making comparisons with Tables I. and II.

TABLE I.—Cost of Concrete Curb and Gutter.

Item.	No. of men.	Lin.ft. per day.	Total wages.	Cost per 100 ft.
Labor:				
Opening trench, 18 × 30-in.	2	144	$3.50	$2.43
Placing & tamping cinders	2	350	3.50	1.00
Setting forms:				
Boss setter	1	...	3.00	...
Assistant setter	1	...	2.00	....
Laborer	1	...	1.75	....
	3	400	$6.75	$1.69
Mixing and placing concrete:				
Clamp man	1	...	$1.75	....
Wheelers	3	...	5.25	....
Mixing concrete	4	...	7.00	....
Mixing finishing coat	2	...	3.50	....
Tampers	1	...	1.75	....
Finishing:				
Foreman and boss finish'r	1	...	4.00	....
Assistant finisher	1	...	3.00	....
Water boy	1	...	.50	....
	14	350	$26.75	$7.64
Total for labor per 100 ft.				$12.75
Materials for 100 lin. ft:	Quantity.		Price.	
Portland cement	8½ bbls.		$1.85	$15.42
Cinders	7.5 yds.		.50	3.75
Gravel	2.5 "		1.00	2.50
Broken stone	2.5 "		1.40	3.50
Sand	1.0 "		1.00	1.00
Total for material per 100 ft.				$26.17
Total for material and labor per 100 ft.				38.93

This is the total cost, exclusive of administration, lumber, tools, interest, profits, etc.

TABLE II.—Cost of Concrete Base for Pavement.

Items.	No. of men.	Sq.yds. per day.	Total wages.	Cost per sq. yd.
Labor:				
Roll'g subgrade. {1 roller. 2 teams. 1 driver.}	1	8,000	$4.75	$0.0005
Mixing and tamping concrete:				
Turning with shovels	6	.....	12.00	.....
Throwing into place	4	.....	8.00	.....
Handling cement	2	.....	3.50	.....
Wetting with hose.	1	.....	1.75	.....
Tamping	2	.....	3.50	.....
Grading concrete	1	.....	1.75	.....
Wheeling stone	6	.....	10.50	.....
Wheeling gravel	4	.....	7.00	.....
Foreman	1	.....	4.00	.....
Total	900		$52.00	$0.058
Total labor per sq. yd.				$0.0585

For 1 sq.yd:	Unit price.	Quantity.	Cost.	
Cement	$0.50 a bbl.	1 barrel.	$0.10	.....
Sand and gravel	1.00 cu.yd.	1/10 cu. yd.	.10	.....
Broken stone	1.40 cu.yd.	1/10 cu. yd.	.14	$0.34
Cost for material and labor per sq. yd.				$0.3985

TABLE III.—Cost of Brick Wearing Surface.

Item.	Force working.	Amount of material handled per day.	Total wages	Cost per sq.yd. cts.
Labor:				
Spread'g sand cushion. 1 man.		300 sq. yds.	$1.75	0.57
Brick, cars to wagons. 10 men.		300 sq. yds.	17.50	1.75
Hauling, 1 mile	8 teams	40 M brick.	24.00	2.40
Unloading, curb line..	8 men.	40 " "	14.00	1.40
Wheeling brk to layers	2 "	40 " "	3.50	1.15
Laying brick	1 "	12 " "	2.50	.83
Sweeping, inspecting and filling joints, sand	1 "	450 sq. yds.	1.75	.39
Rolling pavement	1 team.	800 sq. yds.	3.00	.37
Total cost for labor for 1 sq. yd., cts.				8.87
	Amount.	Price.		
Material: Sand cushion 1/36 yd.	$1.00 cu.yd.	....		0.0277
Brick, f.o.b. destinat'n. 40 sq.yds	16.00 per M	....		.6400
Sand filler				.0023
Total cost for material per sq. yd., cts.				67.00
Total cost, material and labor pr sq.yd., cts.				75.87

Summary of Costs of Pavement.

Grading a sq. yd.	$0.10
Concrete base, a sq. yd.	.3985
Brick wearing surface, a sq. yd.	.7587
Total cost,* a sq. yd.	$1.2572
The contract price was $1.29.	

*Exclusive of court costs and cost of engineering and inspection.

*Abstract of Thesis submitted for degree of B. S. in Civil Engineering, reprinted from "The Technograph."

†Class of 1903, University of Illinois, Champaign, Ill.

STATISTICS OF RAILWAYS OF THE UNITED STATES FOR THE YEAR ENDING JUNE 30, 1902.

The advance statement of the statistician of the Interstate Commerce Commission covering railway operations in the United States for the year ending June 30, 1902, has just been issued, and from it we abstract the following portions which are of the most general interest:

MILEAGE.—On June 30, 1902, the total single-track railway mileage in the United States was 202,471.85 miles, this mileage having increased during the year 5,234.41 miles, this increase being greater than that for any other year since 1890. Including tracks of all kinds, the aggregate length of railway mileage was 274,195.36 miles, which was classified as follows: Single track, 200,154.56 miles; second track, 13,720.72 miles; third track, 1,204.04 miles; fourth track, 895.11 miles, and yard track and sidings, 58,220.93 miles. From these figures it is noted that there was an increase of 8,843.07 miles in the aggregate length of all tracks, of which 3,306.07 miles, or 37.39%, were due to the increase in yard track and sidings. The number of the railway corporations included in the report was 2,037.

EQUIPMENT.—On June 30, 1902, there were 41,228 locomotives in the service of the railways, which was 1,644 more than were in use in 1901. Of the total number of locomotives, 10,318 are classed as passenger locomotives, 23,594 as freight locomotives, 6,683 as switching locomotives, the remainder, 633, not being classified. The total number of cars of all classes in the service of the railways on the same date was 1,640,220, there having been an increase of 89,387 in rolling stock of this class. Of the total number of cars, 36,991 are assigned to the passenger service, 1,546,132 to the freight service, and 57,097 to the direct service of the railways. The foregoing figures do not include cars owned by private companies and firms that are used by railways. The railways of the United States used on an average 206 locomotives and 8,195 cars per 1,000 miles of line; 62,985 passengers were carried, and 1,908,310 passenger miles accomplished per passenger locomotive, and 50,874 tons of freight were carried, and 6,666,499 ton miles accomplished per freight locomotive. Embracing in the term "equipment" both locomotives and cars, the total equipment of railways at the end of the year was 1,681,448. Of this number, 1,306,849 were fitted with train brakes, the increase in this item being 142,801, and 1,648,535 were fitted with automatic couplers, the increase being 98,695. Nearly all locomotives and cars in the passenger service were fitted with train brakes, and of 10,318 locomotives assigned to that service, 9,462 were fitted with automatic couplers. Practically all passenger cars were fitted with automatic couplers. Nearly all freight locomotives were equipped with train brakes and 94% of them with automatic couplers. Of 1,546,132 cars in the freight service, 1,204,929 were fitted with train brakes and 1,520,997 with automatic couplers.

EMPLOYEES.—The number of persons in the employment of the railways of the United States on June 30, 1902, was 1,189,315, or an average of 594 employees per 100 miles of line. As compared with June 30, 1901, the number of employees increased 118,146, or 46 per 100 miles of line. The classification of these employees shows that 43,318 were enginemen, 50,651 firemen, 35,070 conductors, and 91,383 other trainmen. There were 50,489 switchtenders, crossing tenders, and watchmen. Disregarding 1,982 employees not assigned to the four general divisions of employment, it appears that the services of 41,071 employees were required for general administration, 399,592 for maintenance of way and structures, 228,280 for maintenance of equipment, and 518,390 for conducting transportation. The amount paid in salaries and wages to employees during the year ending June 30, 1902, was $676,028,592, which was $65,314,891 in excess of what was paid during 1901. The compensation of the railway employees for 1902 is equivalent to 60.56% of the operating expenses of the railway companies, and 39.16% of their gross earnings.

CAPITALIZATION.—The amount of railway capital outstanding on June 30, 1902, was $12,134,182,964. This represents a capitalization of $62,301 per mile of line. Of the total capital stated, $6,024,201,295 existed in the form of stock, of which $4,722,056,120 was common stock and $1,302,145,175 preferred stock. The amount which existed in the form of funded debt was $6,109,981,669. This amount comprised the following items: Mortgage bonds, $5,213,421,911; miscellaneous obligations, $564,794,588; income bonds, $242,556,745, and equipment trust obligations, $89,208,425. The amount of current liabilities, which is not included in the foregoing figures, was $648,176,194, or $3,328 per mile of line. The amount of capital stock paying no dividends was $2,686,556,614, or 44.60% of the total amount outstanding. Omitting equipment trust obligations, the amount of funded debt which paid no interest was $294,175,243. Of the stock paying dividends, 8.36% of the total amount outstanding paid from 1 to 4%, 13.48% paid from 4 to 5%, 10.24% paid from 5 to 6%, 12.78% paid from 6 to 7%, and 5.54% paid from 7 to 8%. The amount of dividends declared during the year was $185,391,655, which is equivalent to a dividend of 5.55% on the amount of stock on which some dividend was declared. The amount of mortgage bonds paying no interest was $181,485,951, or 3.48%; of miscellaneous obligations, $37,111,220, or 6.57%, and of income bonds, $75,578,072, or 31.15%.

PUBLIC SERVICE.—The number of passengers carried during the year was 649,878,505, showing an increase for the year of 42,600,384. The number of passengers carried one mile—that is, passenger mileage—was 19,689,937,620, there being an increase in this item of 2,336,349,176. There was an increase in the density of passenger traffic, as the number of passengers carried one mile per mile of line in 1902 was 99,314, and in 1901, 89,721. The number of tons of freight carried during the year was 1,200,315,787, an increase of 111,089,347 being shown. The number of tons of freight carried one mile—that is, ton mileage—was 157,289,370,053. The increase in the number of tons carried one mile was 10,212,234,013. The number of tons carried one mile per mile of line was 793,351. These figures show an increase in the density of freight traffic of 32,937 tons carried one mile per mile of line.

The average revenue per passenger per mile for the year ending June 30, 1902, was 1.986 cts. For the preceding year it was 2.013 cts. The revenue per ton of freight per mile was 0.757 ct., while for 1901 it was 0.750 ct. An increase in earnings per train mile appears both for passenger and freight trains. The average cost of running a train 1 mile also increased. The percentage of operating expenses to earnings was 64.66%.

EARNINGS AND EXPENSES.—For the year ending June 30, 1902, the gross earnings from the operation of the

railways in the United States, arising from the operation of 200,154.56 miles of line, were $1,726,380,237, being $137,854,239 more than for 1901. The operating expenses were $1,116,248,747, having increased in comparison with the year preceding $85,851,477. Gross earnings from operation per mile of line were $502 more than for the year ending June 30, 1901, being $8,625. The operating expenses were distributed among the four general divisions as follows: Maintenance of way and structures, $248,381,594, increase, $17,324,992; maintenance of equipment, $213,380,644, increase, $23,081,084; conducting transportation, $609,961,695, increase, $44,695,906; general expenses, $44,197,880, increase, $1,631,327; undistributed, $326,934. The operating expenses amounted to $5,577 per mile of line, or $308 more than for the year immediately preceding.

The income from operation, or the net earnings, was $610,131,520, this item showing an increase as compared with the previous year of $52,002,753. The average amount of net earnings per mile of line for the year ending June 30, 1902, was $3,048, and for 1901, $2,854. The amount of income received from sources other than operation was $196,323,629.

RAILWAY ACCIDENTS.—The total number of casualties to persons on account of railway accidents for the year was 73,250, the number of persons killed having been 8,588 and the number injured 64,662. Of railway employees, 2,969 were killed and 50,524 were injured. These figures show a very considerable increase in the number of employees injured, a result due in part to the unusual increase in traffic and the consequent use of all kinds of equipment and the employment of untried men, and in part to the fact that since July 1, 1901, the carriers have been obliged by law to render monthly reports, under oath, to the Commission, detailing the causes and circumstances surrounding all accidents to employees, the reports being carefully scrutinized and frequently corrected, which results in the return of numerous accidents that, if they had occurred prior to that date, would not have been reported.

These casualties were distributed among three general classes of employees, as follows: Trainmen, 1,674 killed, 21,503 injured; switch tenders, crossing tenders, and watchmen, 200 killed, 1,443 injured; other employees, 1,095 killed, 27,578 injured. The casualties to employees resulting from coupling and uncoupling cars were: Employees killed, 167; injured, 2,864. The corresponding figures for the year 1901 were, killed, 198; injured, 2,768.

The number of passengers killed during the year was 345 and the number injured 6,683. The corresponding figures for the previous year were 282 killed and 4,988 injured. The total number of persons other than employees and passengers killed was 5,274; injured, 7,455. These figures include casualties to persons classed as trespassers, of whom 4,403 were killed and 4,854 were injured. The total number of casualties to persons other than employees from being struck by trains, locomotives, or cars were 4,021 killed and 3,973 injured. The summaries giving the ratio of casualties show that 1 out of every 401 employees was killed, and 1 out of every 24 employees was injured. With reference to trainmen—including in this term enginemen, firemen, conductors, and other trainmen—it is shown that 1 was killed for every 135 employed, and 1 was injured for every 10 employed. One passenger was killed for every 1,883,706 carried, and 1 injured for every 97,244 carried. Ratios based upon the number of miles traveled, however, show that 57,072,283 passenger miles were accomplished for each passenger killed, and 2,946,272 passenger miles accomplished for each passenger injured. The corresponding figures in these latter ratios for the year ending June 30, 1901, were 61,537,548 and 3,479,067 passenger miles for each passenger killed and each passenger injured, respectively.

STREAM FLOW AND STORAGE IN RELATION TO IRRIGATION.*

The measurements of the water used in irrigation have done much to promote two reforms in the irrigation practice of the arid region. They have shown that the losses from seepage are much larger than had before been supposed. This is leading to better construction and maintenance of canals in order to lessen this waste. They are showing the influence which water-right contracts exert in promoting thrift and economy or in encouraging wasteful or excessive use of water. When streams carried a surplus and water had little value the chief object of canal companies was to secure customers, and many of the earlier contracts were loosely drawn. The simplest method of charging for water was by the acres irrigated and many contracts provide for payment of water charges on this basis.

Under such contracts farmers have no incentive to economize. The more water they use on an acre the more they are getting for their money, and, in many instances, this has been the chief cause of the wasteful use of water. In a few places the agents of this investigation have induced companies to make changes in such contracts by charging for the volume delivered. The saving has been so marked that the reform will go on. In a comparative test made in the Pecos Valley in New Mexico those who paid by the acre used enough water to cover the land to a depth of 2.57 ft. Those who paid for the quantity used applied only water enough to cover the land to a depth of 2.04 ft., a saving of 20.6%. An increase of one-fifth in the area irrigated would be no insignificant gain. In one of the tests made in Idaho those who paid for water by the acre used enough to cover their land to a depth of 5.73 ft. Those who paid for what they used got along with enough to cover the land to a depth of 4.14 ft., a saving of 1.59 acre-feet for each acre, or nearly 28%.

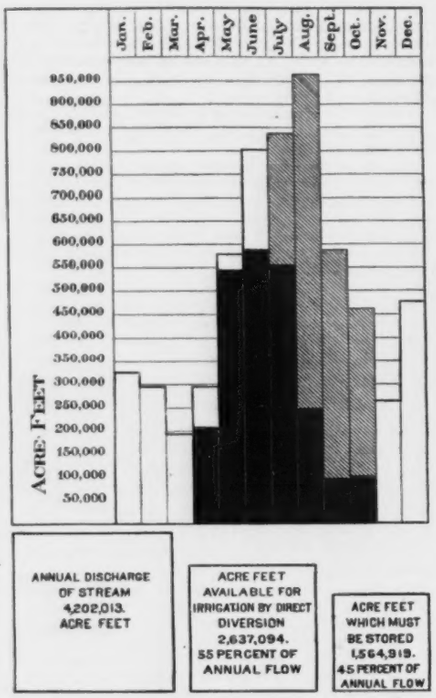
The studies of the duty of water throw much light on the amount of storage which will be required in order to make complete use of the water supply. With very few exceptions the rise and fall of streams does not correspond to the varying needs of crops. There is too much water at some times and too little at others. The function of the reservoir is to act as a regulator, to hold back water when it is not required and supply it when it is.

On some streams the amount of regulation required is small because their flow is well maintained throughout the irrigation period. Rivers like the Grand, Green, and Bitter Root, which rise in lofty mountains with timber-covered slopes, belong in this class. The snow melts late and the water runs off gradually. Natural lakes of large size serve to regulate other rivers like the Yellowstone and Snake. On the other hand, rivers which head in mountains from which the timber has been removed or in mountains of low elevation are torrential in character, carrying the bulk of their flow in sudden floods. These irrigate only a small area by direct diversion, and reservoirs are a necessity.

In all cases the aim should be to make the largest practicable use of the natural flow and limit storage to the regulation which this requires. The cost of building and operating reservoirs is an added tax on water users, from which all the land which can be irrigated directly from the stream is relieved. In order to determine how much water has to be stored and how much can be applied directly to the land, it is necessary to ascertain both the months when water is required by irrigators and the percentage of the total supply needed each month. To do this, the water used must be measured, and measured where irrigators have all the water they need. Comparing measurements of this character with the flow of streams gives a scientific basis for the planning of storage works. It will require several years' study on each stream in order to avoid errors caused by seasonal variations and secure a safe average, but the results of a single year's study show how valuable this data is destined to be in those sections where water is scarce and land abundant. In order to illustrate this a few diagrams have been prepared showing the results of comparing the percentages of water used in the different months of the irrigation period with the run-off of the stream from which the water was taken. The stream flow has been taken from the records of the United States Geological Survey; the water used, from the measurements of this office.

The tables and diagrams which follow (only one diagram reproduced here.—Ed.) indicate approximately the extent of storage which will be needed to use all the water of three streams where irrigation is already important.

*From "Review of Irrigation Investigations for 1902," by Elwood Mead, Irrigation Expert in Charge; Reprinted from Annual Report of the Office of Experiment Stations for 1901-2, A. C. True, Director.



Irrigation Investigations—Diagram Showing Flow of Yakima River, Washington, and Storage Required for its Complete Use in Irrigation.

White areas represent amount of flow during non-irrigation period and unused flow during April, May and June. Black areas represent amount of flow which could be used by direct diversion. Hatched areas represent the volume which must be stored and the time of its use.

Percentage of Annual Flow of Rivers Discharged Each Month.

Month.	Yakima River, Washington, %	Gallatin River, Montana, %	Boise River, Idaho %
January	7.8	3.8	7.5
February	7.1	3.4	2.7
March	4.7	3.6	3.9
April	7.1	3.8	14.5
May	13.8	6.6	20.8
June	19.1	29.1	25
July	13.2	24.7	12.2
August	4.7	7.1	3.7
September	2.4	4.8	2.4
October	2.4	4.7	2.9
November	6.3	4.4	3.1
December	11.4	4	3.3
Total	100	100	100

Percentage of Flow of Canals During Irrigating Season Discharged Each Month.

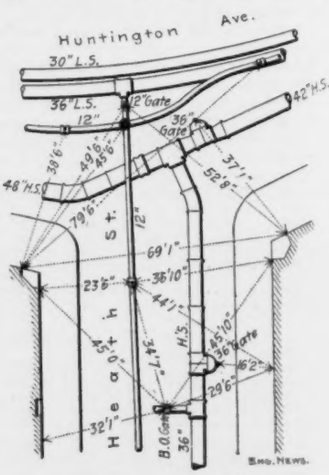
Month.	Sunnyside Canal, Yakima River, %	Middle Creek Canal, Gallatin Valley, %	Rust Lateral Ridenbaugh Canal, Boise River, %
April	5	..	3.2
May	12.8	..	17.5
June	14.4	29.8	17
July	20.1	39.9	14.6
August	23	20.7	18.6
September	13.3	9.6	16.7
October	11.4	..	12.4
Total	100	100	100

MAP SHOWING LOCATION OF GATES AT IMPORTANT CONNECTIONS; BOSTON WATER-WORKS DISTRIBUTION SYSTEM

By Frederic I. Winslow.*

The accompanying illustration shows the method used in the City of Boston to make clear to those in direct charge of the system the location of the gates at important connections.

The gates are tied to each other, and to adjacent permanent points, so that they may be readily found on the darkest night or when covered with snow.



Method of Locating Pipe Connections and Gates, Boston Water-Works.

These plans are made of a convenient size (4 × 7 ins.), and after being printed on both sides of blue print paper are bound and given to the foreman. A total of 48 sheets, or 96 pages, comprises a book.

*Assistant Engineer, Engineering Department, Boston, Mass.